Final Report

Pennsylvania Recovered Material Composition Study

Pennsylvania Department of Environmental Protection

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PENNSYLVANIA RECOVERED MATERIAL COMPOSITION STUDY

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Host Facilities
Blue Mountain Recycling MRF (Philadelphia, Philadelphia County)
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Introduction

Compared to many states, the Commonwealth of Pennsylvania has good data on the amounts of recyclables that are diverted from disposal for the purpose of recycling. A limitation of the Commonwealth's reporting system, however, is that many municipalities do not have good data on the detailed composition of recyclables that are collected within their jurisdictions, so they must either estimate material composition or report materials in a mixed category. The purpose of this study was to develop a better understanding of the composition of recyclables collected in Pennsylvania. This study had two primary objectives:

- Provide insight on the composition of residential and commercial recyclables that are collected and processed across Pennsylvania from a wide range of collection program types and materials recovery facility (MRF) processing configurations.
- Develop recyclables composition data that can then be used by communities and/or the Pennsylvania Department of Environmental Protection (DEP) to estimate recyclables amounts by material type that otherwise would be reported as mixed recyclables.

Table ES-1 shows the amounts of "mixed" material for certain categories that are processed by materials recovery facilities in the Commonwealth.

Table ES-1
Size of "Mixed" Categories Processed by MRFs (2001 Tons)

Category	Curbside	Drop-Off	Commercial	Total
Commingled Materials	140,638	54,464[1]	57,871	252,972
Glass: Mixed	6,932	1,564	3,052	11,548
Paper: Mix	62,023	10,316	125,554	197,893
Plastic: Mixed	2,718	1,501	9,272	13,491
Total	**212,311**	**67,845**	**195,749**	**475,904**

[1] Includes 46,303 tons that was added by the DEP as a special line item to account for additional Recycling Performance Grant tons.

The total amount of material that was reported in "mixed" categories in the Commonwealth in 2001 was 1,300,000 tons, approximately 600,000 tons of which was miscellaneous items such as additional scrap metal estimate, ash recycling, metals recovered from ash, and asphalt. Focusing on obtaining composition data for the above categories of materials for this study was therefore thought to provide significant information on mixed materials reported in the Commonwealth.

A total of 332 samples of recyclables and facility rejects and residues were taken and sorted at nine different MRFs to develop composition data. Further, by targeting

MRFs that provide vastly different processing capabilities, the study sought to develop some comparative data between recycling program types.

Composition of Incoming Materials

Table ES-2 shows the average composition of two streams of material that are often reported as mixed — commingled containers and single-stream recyclables.

Table ES-2
Composition of Incoming Residential Commingled
Containers and Single Stream Recyclables

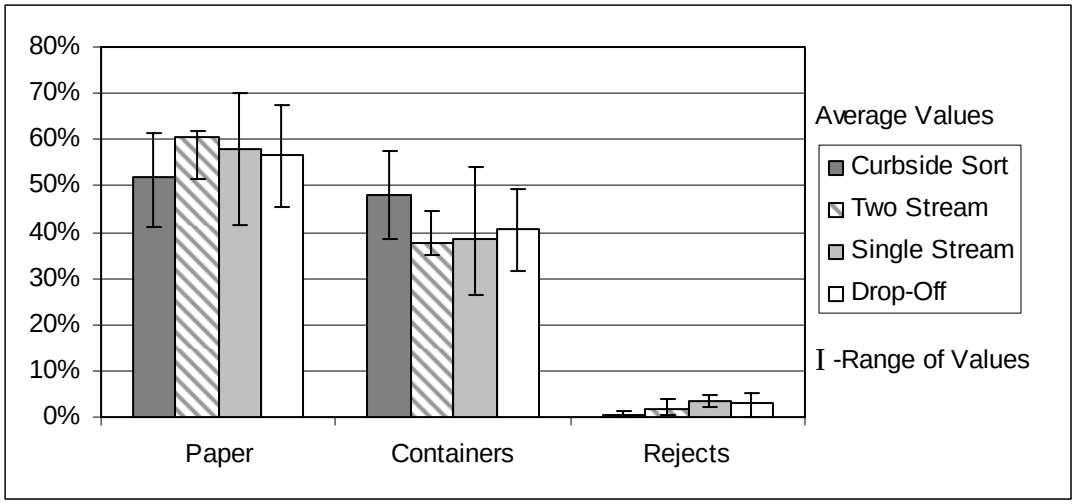
Category	Commingled Containers Composition	Single Stream Composition
Newspapers		45.7%
Glossy Paper (Inserts)		7.6%
Magazines (Subscription)		1.8%
Corrugated Containers		1.4%
Office Paper		0.5%
Phone Books		0.7%
Mixed (Other Recyclable) Paper		1.3%
Subtotal Paper		*58.9%*
#1 PET Bottles	12.9%	5.0%
#2 HDPE Bottles	12.4%	6.9%
Clear Glass	21.9%	7.0%
Green Glass	11.9%	3.5%
Amber Glass	12.9%	3.7%
Mixed Cullet	9.6%	7.2%
Steel Cans	11.7%	5.6%
Aluminum Cans	6.4%	2.0%
Aluminum Other	0.4%	0.2%
Subtotal Containers	*100%*	*41.1%*
Total	100%	100%

The composition data shown in Table ES-2 is for incoming material, excluding contaminants. Because significant variation in composition was observed from community-to-community and MRF-to-MRF, the averages shown in Table ES-2 should not be relied upon to represent the composition of a particular community's recovered material. The composition data shown in Table ES-2, however, is a good representation of Commonwealth averages for incoming recyclables that are often reported as mixed.

The following figures illustrate the composition of incoming recyclables and the variation that was observed.

Figure ES-1 compares the relative proportions of paper, containers, and rejects[1] in incoming residential recyclables based on the type of collection program.

Figure ES-1
Composition of Incoming Residential Recyclables



As the range of values in Figure ES-1 shows, the relative proportions of paper and containers varied significantly from sample-to-sample. However, the average values of the different collection styles were quite similar, except for curbside sort, which showed a lower proportion of paper and higher proportion of containers compared to the other collection styles. Two factors are thought to contribute to this difference:

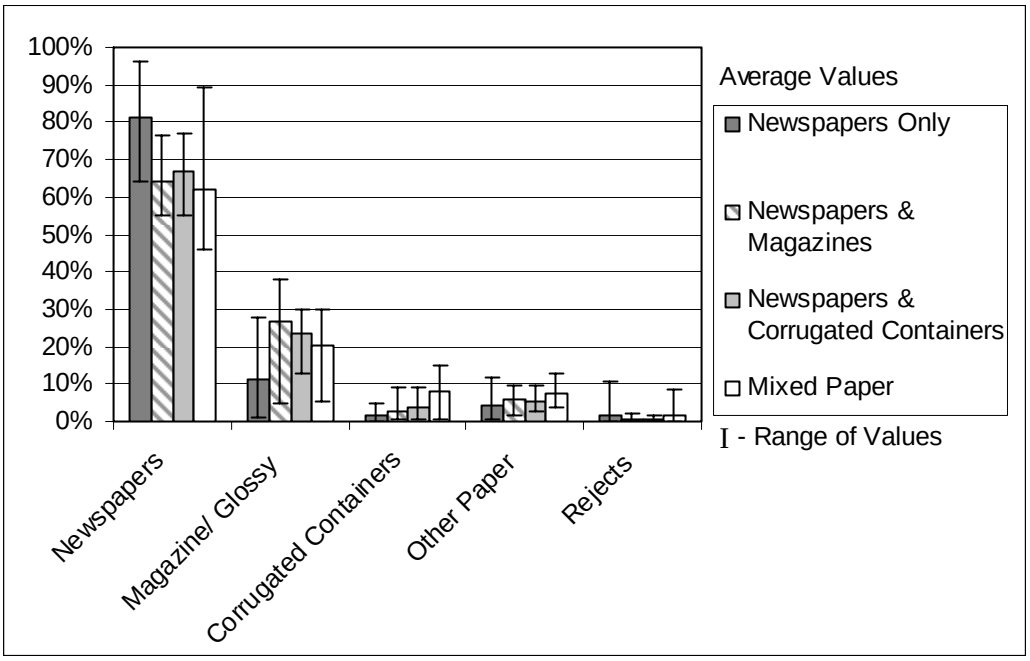
- Curbside sort systems often limit paper to only newspaper because of the limited number of collection vehicle compartments into which materials can be sorted.
- Curbside sort collection systems are often utilized in rural areas where newspapers are smaller and distributed less frequently.

Rejects were found to be lowest in curbside sort programs on average. This is not surprising since the collector of the material has the opportunity to leave rejects in the collection bin. However, the range of values for the differing collection styles indicates that rejects can be minimized in any collection style.

Figure ES-2 compares the relative proportions of paper products and rejects found in incoming residential paper based on the type of paper products requested by programs.

[1] In the context of incoming materials delivered by recycling collection trucks, rejects are those materials that are not targeted for recovery. Examples include contaminated/non-recyclable paper, plastic bags, #3-#7 plastic bottles, non-bottle plastic containers, non-container rigid plastic, non-container ferrous metals, non-ferrous metals other than aluminum cans and aluminum foil, organic materials, and other inorganic or multi-material products.

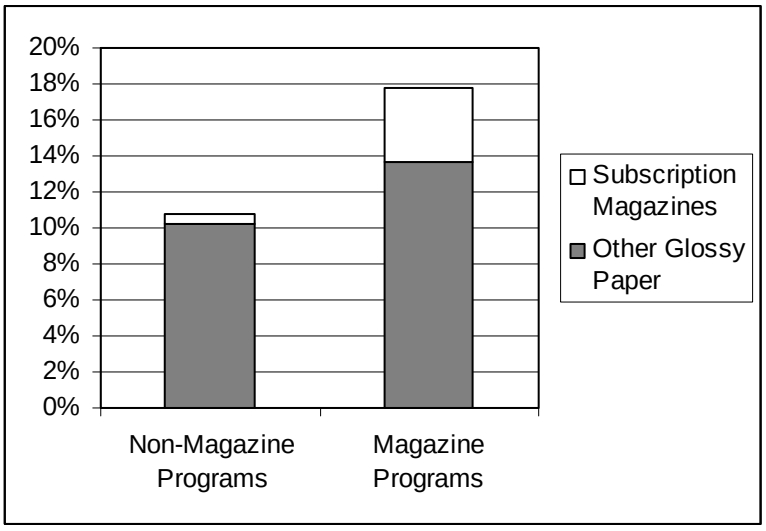
Figure ES-2
Composition of Incoming Residential Paper by Paper Program Type



As Figure ES-2 shows, the percentage of newspapers decreases as additional types of paper are added to the collection program.

Figure ES-3 shows further detail on the percentages of subscription magazines and other glossy paper (primarily newspaper inserts) found in incoming residential paper based on whether magazines were requested in the collection program.

Figure ES-3
Proportions of Subscription Magazines and Glossy Paper in Incoming Paper



It should be noted that only a portion of the samples included in Figure ES-2 were further sorted to produce the results shown in Figure ES-3. As a result, the total magazine/glossy values depicted in each figure differ somewhat from each other.

Figure ES-4 compares the relative proportions by major material type of incoming residential containers and rejects. Significant variation was seen among the container proportions for individual samples as the ranges of values show. Significant variation is also seen between the average proportions of glass containers, plastic bottles, steel cans, and aluminum cans when comparing the different collection system types. When computing the averages, only data for communities that targeted all four materials in their recycling programs were included, so the differences cannot be attributed to some programs not accepting glass or plastics and there is no other readily apparent cause for the differences.

Figure ES-4
Composition of Incoming Residential Containers

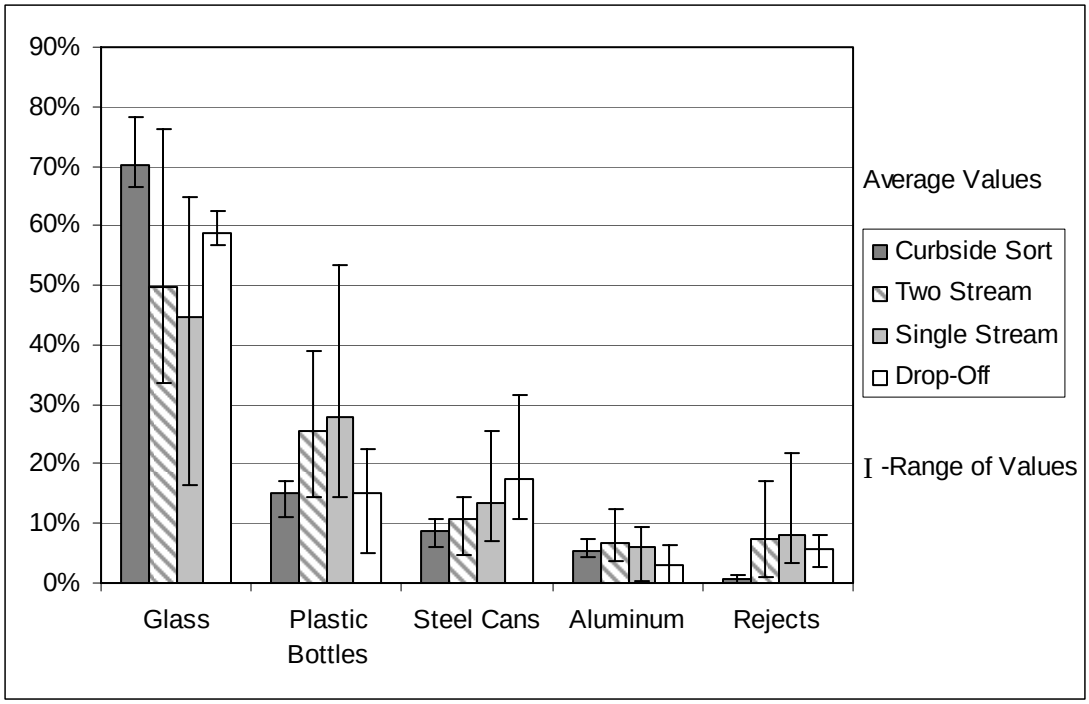


Figure ES-5 provides additional detail on the composition of incoming plastic bottles.

Figure ES-5
Composition of Incoming Plastic Bottles

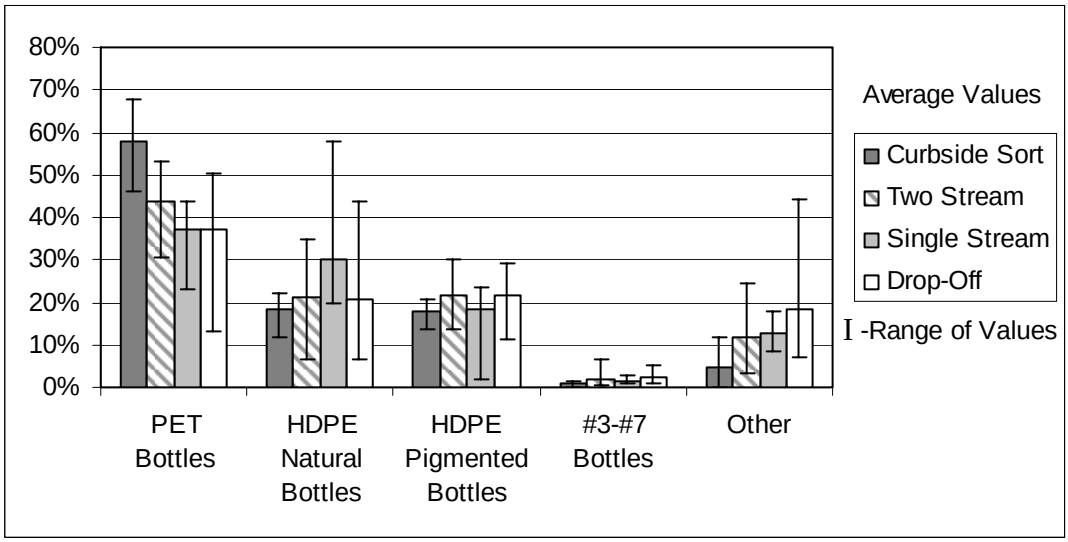


Figure ES-5 is noteworthy in that it shows that other materials (i.e., bags, non-bottle plastics, non-plastic items) far outweighs the amount of #3-#7 bottles that are received. Often, #3-#7 bottles receive much of the attention when the issue of plastics contamination is discussed.

Glass containers were sorted in this project into subcategories of clear, green, amber, and mixed color cullet. Figure ES-6 shows the composition of incoming glass containers that are manually sortable by color (i.e., mixed color cullet was not sorted).

Figure ES-6
Color of Incoming Glass Containers

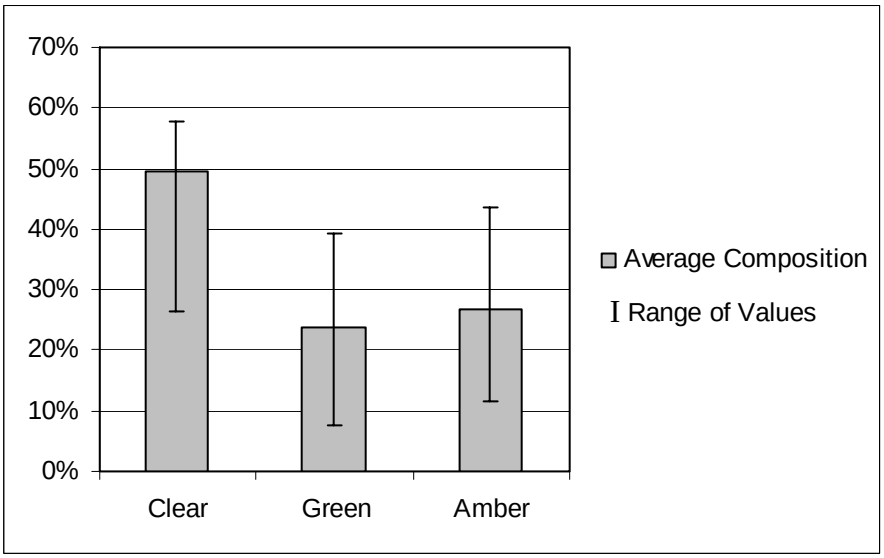
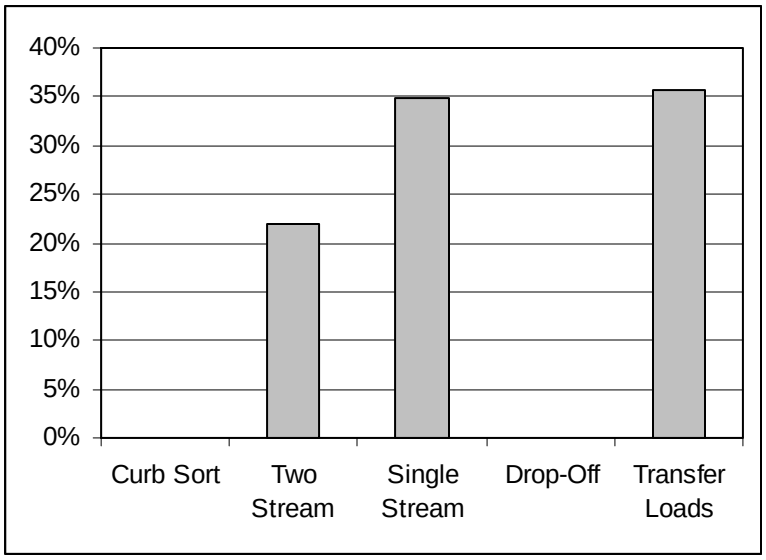


Figure ES-6 shows that clear glass is predominant, followed by amber and then green glass. The large range of values should be noted, indicating that color composition varied widely among all the samples. It is thought that the color mix of glass at the local level is highly dependent on local socio-economic factors and product consumption patterns. In particular, green glass from wine and beer bottles can cause differences in the color mix depending on local consumption patterns.

Figure ES-7 shows the percentage of glass containers that were received as mixed color cullet from the collection systems included in this study.

Figure ES-7
Proportion of Mixed Cullet in Incoming Glass Containers



Often, mixed color cullet is disposed as residue. As Figure ES-7 shows, the greatest percentage of mixed cullet in incoming glass containers occurs in single stream collection systems and in loads of transferred recyclables. Collection of single stream recyclables is often accomplished using compacting vehicles, which may contribute to breakage. The additional handling associated with loading and unloading recyclables for transfer over long distances is thought to result in the higher breakage found in transfer loads. The findings of this study seem to support these hypotheses. It should be noted that the percentage of glass that becomes mixed color cullet is normally greater than is shown in Figure ES-7 because additional breakage often occurs after receipt at MRFs through mechanical manipulation of recyclables by loaders and the sorting systems of the recycling facilities.

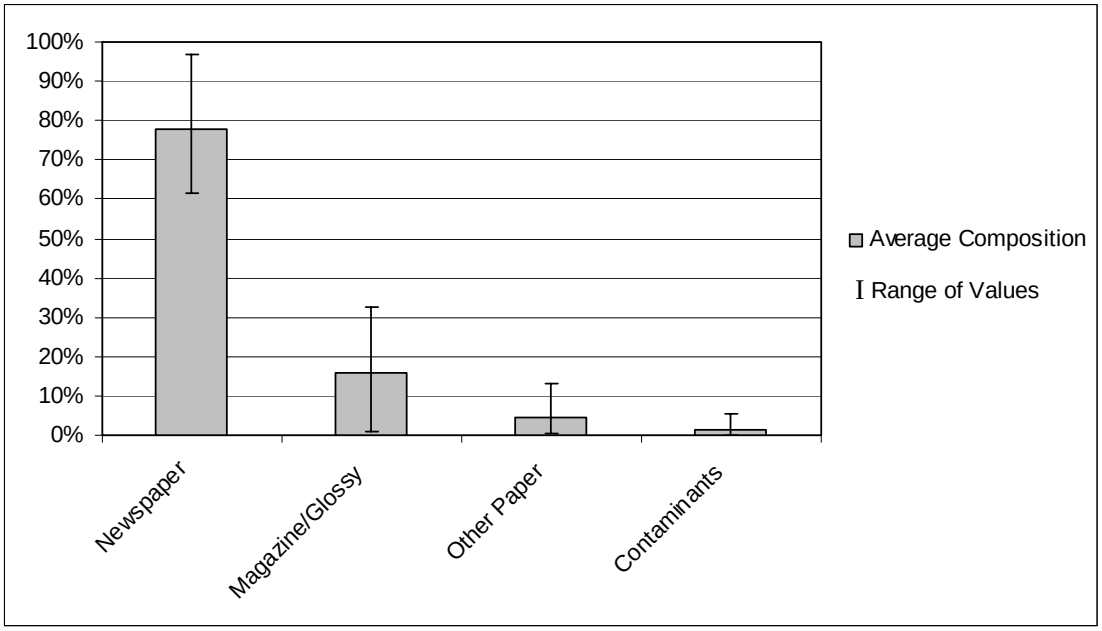
Composition of Processed Materials

Contaminants are materials that recycling end markets don't want in sorted materials. Each end market has a different definition of contamination. For example, some newspaper recycling mills consider magazines (which are not rejects in this study) to be contaminants, whereas others do not; also, steel cans that are missed during sorting and are baled with aluminum are considered to be a contaminant by aluminum

markets. When presenting the composition of processed materials, the term "contaminant" is used in this report to refer to the sum of both reject materials and otherwise desirable materials that were not properly separated during processing and ultimately wound up in the wrong processed material stream.

Figure ES-8 shows the composition of processed "newspaper" marketed by the MRFs.

Figure ES-8
Composition of Processed Newspaper



As Figure ES-8 shows, in some cases the processed "newspaper" was almost exclusively newspaper, whereas in other cases the "newspaper" contained almost 40 percent magazines and other paper. The reason for the large variation depends on what individual paper mills consider to be "contaminants." Paper mills that use a clay deinking technology generally accept magazines in their newspaper because the clay coating on glossy magazine stock aids in their deinking process. Mills that use different deinking technologies generally don't accept magazines in their newspaper bales. Two grades of newspaper are also commonly sold and the price difference between #6 and #8 newspaper grades (and other paper grades such as mixed paper) can also affect the average composition as MRFs adjust their processing based on market price and demand for different paper grades.

Composition of MRF Rejects and Residues

"Rejects," in the context of processing, are what the MRFs (as defined by their markets) regard as contaminants and which they by practice separate for disposal from a recovered material stream, such as film bags and wet newspaper. When discussing residues[2] in the context of processing, this report uses that term to describe materials that are negatively discharged from one or more points in the processing lines. Residue often includes significant quantities of desired recyclables that were either missed on the sorting line or that became uneconomical to recycle, such as glass containers that became broken mixed color cullet. Both "rejects" and "residues" terms can therefore include both materials that are commonly considered to be "recyclable" as well as materials that may commonly be considered to be "contaminants."

Normally, MRFs have more than one ejection point for rejects and residues. Furthermore, the composition of reject and residues can vary significantly at any given ejection point over the course of a processing day. Developing reliable residue composition statistics would be costly and was not a primary objective of the project. However, reject and residue samples were taken and "snapshot" compositions were developed in order to give a sense of the composition of MRF rejects and residues. These "snapshot" compositions are shown in Figure ES-9.

Figure ES-9
Composition of Reject and Residue Samples

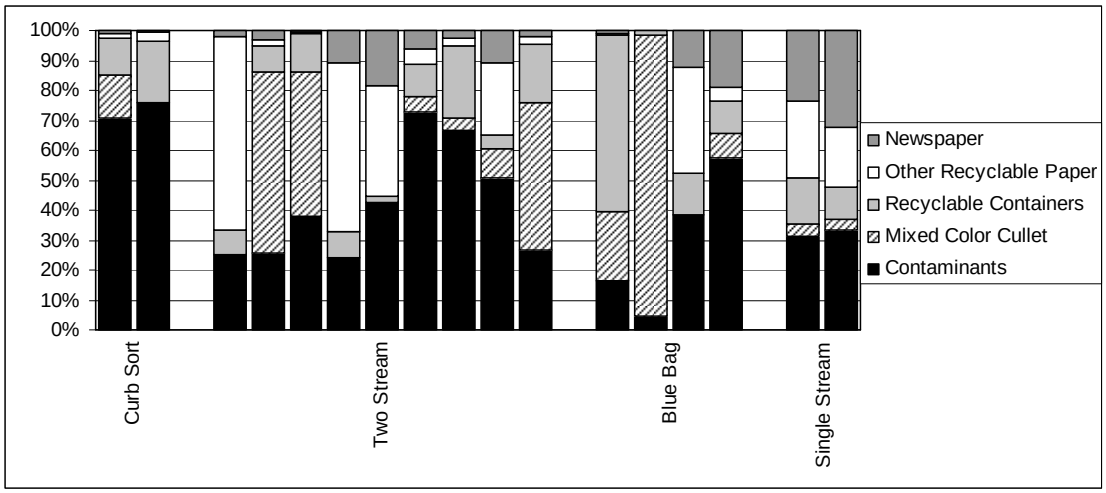


Figure ES-9 shows that reject and residue streams from curb-sort systems are primarily composed of contaminants – relatively few desired recyclables are disposed. Alternatively, as more commingling occurs, greater percentages of desired recyclables are lost at reject or residue ejection points and are ultimately disposed.

[2] Residues are strictly defined to be desired materials that are ultimately disposed by the MRF because of collection or processing equipment limitations or operating practices. Frequently, the term "residues" is loosely used to collectively describe all materials (both rejects and residues) that are disposed by MRFs. This report does not use the term "residues" in this sense.

R. W. Beck further analyzed the size and type of plastic bottles found in the reject and residue samples and compared the result to the incoming and processed material compositions. Figure ES-10 shows the result of this analysis for PET bottles.

Figure ES-10
Composition of PET Bottles in Incoming,
Processed, and Reject and Residue Streams

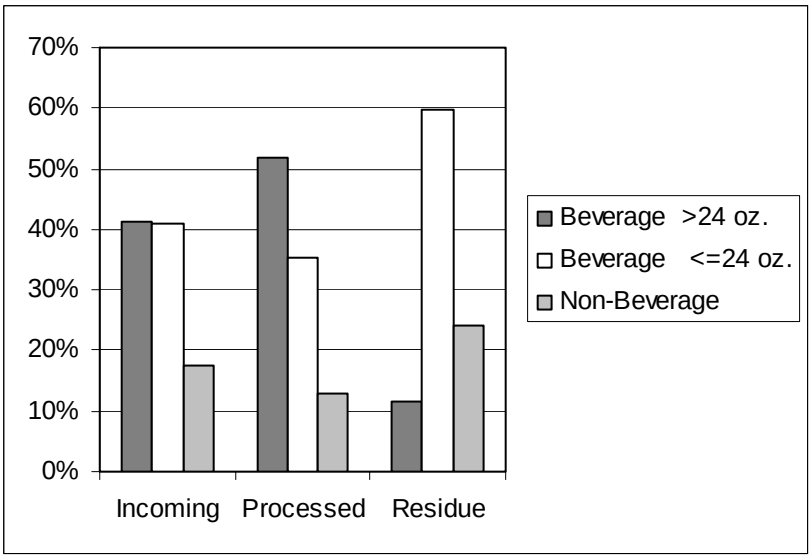


Figure ES-10 shows that single service PET beverage bottles were nearly equal to large PET bottles on entering the MRFs but were on average significantly less in the processed material. They also were the most prevalent type of PET bottles found in rejects and residues. This data demonstrates that significant numbers of small PET beverage bottles are missed on the sorting lines and go off the ends of the sorting belts to be disposed as residue.

Section 1
METHODOLOGY

1.1 Introduction

Compared to many states, the Commonwealth of Pennsylvania has good data on the amounts of recyclables that are diverted from disposal for the purpose of recycling. A limitation of the Commonwealth's reporting system, however, is that recycling data is collected at the municipal level and many municipalities do not have good data on the detailed composition of recyclables that are collected within their jurisdictions as materials are often collected commingled.

The total amount of material that was reported in "mixed" categories in the Commonwealth in 2001 was 1,300,000 tons, which is 16 percent of all tons reported. The purpose of this study is to develop a better understanding of the composition of recyclables collected in Pennsylvania. This study has two primary objectives:

- Provide insight on the composition of residential and commercial recyclables that are collected and processed across Pennsylvania from a wide range of collection program types and materials recovery facility (MRF) processing configurations.
- Develop recyclables composition data that can then be used by communities and/or the Pennsylvania Department of Environmental Protection (DEP) to estimate recyclables amounts by material type that otherwise would be reported as mixed recyclables.

Field data were collected for this study by sorting recyclables over two periods, first during the late summer and fall of 2002 and second during the spring of 2004. The first period focused on meeting the first objective by sampling material from a wide variety of programs and MRFs. The second period sampled material from MRFs serving counties that compose a large percentage of recyclables that are reported as mixed to the DEP.

At each of the participating MRFs, data was collected on the composition of:

- Incoming residential and commercial material;
- Rejects and residues ejected at various locations from the processing lines; and
- Processed materials, particularly plastic and paper that can be processed to different grade compositions or that may be sold as mixed grades.

Material was sorted into 36 recyclables and contaminant categories for the first period sort and 34 recyclables and contaminant categories for the second period sort. The reason for the difference in the number of categories between the two periods was the desire to obtain plastic beverage bottle size information (single-serving versus multi-serving) during the first period sort, and the desire to obtain subscription magazine recycling data separate from non-subscription catalog and newspaper glossy insert data during the second period sort. Table 1-1 on the following page shows the materials categories used for this study.

Table 1-1
Materials Sort Categories

Category No. by Period		Material Category	Material Definition
1	2		
Paper			
1	1	Newspaper	Printed and unprinted ground wood newsprint, excluding glossy paper inserts that are often included with newspapers.
2	2	Corrugated Cardboard	Old Corrugated Containers (OCC) and Kraft Paper - Kraft linerboard and containerboard cartons and shipping boxes with corrugated paper medium (excludes wax or plastic coated boxes). Includes Kraft paper bags.
3	3	Office	High-grade paper. Bond, rag-content, or stationery grade paper without color. Includes ledger, photocopy paper, computer printouts, index cards, and envelopes.
4		Magazine/ Glossy	Magazines and catalogs printed on glossy, coated paper stock.
	4	Subscription Magazines	Periodic subscription magazines printed on glossy, coated paper stock.
	5	Other Glossy	Catalogs, non-subscription magazines, newspaper inserts, and all other glossy or coated paper stock.
5	6	Paperboard	Rigid paper without a corrugated center layer including cereal boxes, cartons, tissue/toweling roll cores, and poster board.
6	7	Junk Mail	Mail that includes envelopes with windows and colored and glossy inserts.
7	8	Phone Books	Telephone directories.
8	9	Other Books	All hard and soft-cover bound books.
9	10	Other Recyclable Paper	Low grade recyclable paper including colored paper, manila folders, construction paper, wrapping paper, molded pulp egg cartons/carriers, and blue prints.
Containers			
10	11	Polycoated/ Aseptic Paper Containers	Polycoated gable top beverage cartons (such as milk and orange juice cartons) and aseptic drink boxes. Excludes non-beverage polycoated paperboard boxes.
Plastic			
	12	#1 PET Beverage Bottles	Blow molded plastic beverage bottles labeled #1 PET
11		#1 PET Beverage Bottles > 24 ounces	Blow molded plastic beverage bottles labeled #1 PET with a fluid volume of >24 ounces

Category No. by Period		Material Category	Material Definition
1	2		
12		#1 PET Beverage Bottles <= 24 ounces	Blow molded plastic beverage bottles labeled #1 PET with a fluid volume of <=24 ounces
13	13	#1 PET Non-Beverage Bottles	Blow molded plastic bottles and jars labeled #1 PET containing ketchup, peanut butter, salad dressing, cooking oil, and cleaning products.
	14	#2 HDPE Natural Beverage Bottles	Blow molded plastic bottles labeled #2 HDPE not made with color additives containing beverages such as milk, juice, and water.
14		#2 HDPE Natural Beverage Bottles > 24 ounces	Blow molded plastic beverage bottles labeled #2 HDPE not made with color additives with a fluid volume of >24 ounces
15		#2 HDPE Natural Beverage Bottles <= 24 ounces	Blow molded plastic beverage bottles labeled #2 HDPE not made with color additives with a fluid volume of <=24 ounces.
16	15	#2 HDPE Natural Non-Beverage Bottles	Blow molded plastic beverage bottles labeled #2 HDPE not made with color additives containing cleaning products, vinegar, etc.
	16	#2 HDPE Pigmented Beverage Bottles	Blow molded plastic bottles labeled #2 HDPE not made with color additives containing beverages such as milk, juice, and water.
17		#2 HDPE Pigmented Beverage Bottles > 24 ounces	Blow molded plastic beverage bottles labeled #2 HDPE made with color additives with a fluid volume of >24 ounces, such as white or yellow milk jugs and orange juice bottles.
18		#2 HDPE Pigmented Beverage Bottles <= 24 ounces	Blow molded plastic beverage bottles labeled #2 HDPE made with color additives with a fluid volume of <=24 ounces.
19	17	#2 HDPE Pigmented Non-Beverage Bottles	Blow molded plastic beverage bottles labeled #2 HDPE made with color additives containing cleaning products, motor oil, etc.
	Glass		
20	18	Clear	Recyclable clear beverage and food bottles and jars.
21	19	Green	Recyclable green beverage and food bottles and jars.
22	20	Amber	Recyclable amber beverage and food bottles and jars.
23	21	Mixed Cullet	Broken mixed colors of glass food and beverage containers of too small a size to be sorted by hand (less than 3 inches).

Category No. by Period		Material Category	Material Definition
1	2		
		Metal	
24	22	Steel Cans	All coated and tin-free ferrous food and beverage cans. Includes bi-metal cans, aerosol spray cans, and paint cans.
25	23	Aluminum Cans	All aluminum food and beverage containers and aerosol spray cans.
26	24	Other Aluminum	Foils, trays, and other aluminum packaging materials.
		Contaminants [1]	
27	25	Contaminated/Non-Recyclable Paper	Low-grade non-recyclable paper. Includes tissue paper, napkins, paper towels, paper plates, paper food cartons, cigarette packages, waxed paper, wax or plastic coated corrugated boxes, and carbon paper, whether or not they are contaminated with fluids or food. Includes all other grades of paper if substantially contaminated with fluids or food waste, including pizza boxes.
28	26	Plastic Film Bags	Any film plastic including retail bags, garbage bags, dry cleaner bags, and newspaper sleeves.
29	27	#3-#7 Plastic Bottles	Blow molded plastic bottles and jars labeled #3, #4, #5 #6 or #7.
30	28	Other Plastic Containers	Includes other thermoformed or injection-molded rigid or flexible plastic containers not captured in the above categories. Includes tubs, trays and containers labeled #1, #2, #3, #4, #5, #6 and #7.
31	29	Non-Container Rigid Plastic	Includes all non-container rigid plastics such as pipe, electrical components, automotive components, toys, and foamed plastics.
32	30	Non-Recyclable Glass	Flat, pressed and blown glass products such as light bulbs, mirrors, decorative items and fixtures, windows, and cookware.
33	31	Other Ferrous	Ferrous and alloyed ferrous scrap metals from any source.
34	32	Other Non-Ferrous	Copper, brass, pipe, tubing, stainless steel, aluminum siding.
35	33	Other Organics	Organic materials not otherwise categorized, such as food, grass, wood, leather, natural fibers, manure, cork, hemp rope, and wicker products.
36	34	Other Inorganics	Inorganic material including rock, dirt, sand, and certain manufactured products composed of entirely inorganic materials.

[1] Contaminant categories are defined to be consistent with what most residential recyclables processing facilities consider to be contaminants in their incoming materials. Several of the categories, such as metals and film plastics, are recyclables that are desired by other types of recycling facilities.

1.2 Selection of MRFs

1.2.1 First Sorting Period

A variety of recycling collection styles are employed across the Commonwealth, supported by processing facilities with many different processing configurations. One objective of the study was to assure that sampling and sorting captured data from a broad cross-section of recycling collection styles and MRF processing configurations. The following areas of variation were considered when selecting the facilities at which material was to be sampled for the first sorting period:

- Type of collection program:
  - Residential curbside;
  - Residential drop-off; and
  - Commercial.
- Collection style:
  - Curb-sorted;
  - Two-stream commingled (i.e., paper and containers);
  - Single stream (i.e., all materials mixed in one truck compartment); and
  - Source-separated (e.g., residential or commercial corrugated containers).
- Waste shed (urban/suburban/rural and different geographic regions of the Commonwealth); and
- Facility ownership (public/private).

Based on input from the DEP and the Professional Recyclers of Pennsylvania (PROP) the following five MRFs were selected for the first sorting period:

1. **Centre County MRF –** A publicly owned and operated facility that accepts curb-sorted material from urban, suburban, and rural communities;
2. **Lackawanna County MRF** – A publicly owned and operated facility that accepts recyclables in three streams (commingled containers, paper, and corrugated containers) from a wide regional area;
3. **Northern Tier Solid Waste Authority MRF** – A publicly owned and operated facility in a rural area that accepts curb-sorted and drop-off recyclables;
4. **Pittsburgh Recycling MRF –** A privately owned facility that accepts dual stream recyclables from a large urban area using both conventional and blue bag collection[3]; and

[3] Conventional curbside collection systems normally provide one or more reusable bins to program participants for storing and setting out recyclables for collection. The blue bag system evaluated in this study asks participants to use disposable blue bags for storing and setting out recyclables for collection by a separate recycling-only collection vehicle. The term "blue bag" system is more often used to indicate that the blue bags of recyclables are collected with solid waste in the same truck compartment and separated from the refuse at a processing facility.

5. **Recycle America of York MRF** – A privately owned facility that serves a wide area and is Pennsylvania's first single stream MRF.

As the list shows, the selected MRFs were drawn from a variety of geographic regions, processing systems, ownership, and collection styles (drop-off, curb-sort, dual-stream, blue-bag, and single-stream), providing a wide range of comparative data.

1.2.2 Second Sorting Period

The objective of the second sorting period was to develop representative estimates of recovered material composition by sorting a larger number of samples for materials that are commonly reported as mixed, and for materials from MRFs that serve communities reporting significant amounts of mixed residential recyclables.

To develop a MRF sampling and sorting plan that met the objective of the second series of sorts, R. W. Beck analyzed Act 101 annual reports and the Commonwealth's detailed annual recycling database of recovered material quantity data reported to the DEP for each county and municipality. DEP's web-based recycling reporting tool is capable of gathering very detailed recycling data from Pennsylvania county recycling coordinators. County recycling coordinators are responsible for gathering data relative to the recycling programs within their municipalities, as well as information on private sector haulers who provide both residential and commercial recycling collection services in their respective communities. With the large number of entities responsible for collecting and reporting recycled material quantities, it is not always possible to obtain complete and detailed data of the types of materials being recovered, particularly in instances where haulers or processing facilities obtain materials from many different communities.

R. W. Beck analyzed data from DEP's recycling database for 2001, the most recent year from which data that was verified and available for analysis at the time this study was conducted. A review of the database revealed that data are collected in 62 categories (not including special categories for ash, metal from ash, and ISRI additional metals). For these 62 categories, entries are split into three recovery methods of residential, drop-off, and commercial, for a total of 186 possible entries of detailed data for each community.

Some of the data categories can be considered to be "mixed" categories, meaning that they may include more than one distinct type of recyclable material. Table 1-2 shows these categories.

Table 1-2
List of "Mixed" Categories

Category	DEP Code	May Include
Commingled Materials	XXX	Multiple categories of containers
Glass: Mixed	GL2	Clear, green, brown glass
Mixed Metals	MM1	Combinations of ferrous/non-ferrous metals
Mixed Cans	MX2	Steel and aluminum cans
Non Ferrous	N01	Combinations of non-ferrous metals
Paper: Mix	PA3	Combinations of paper grades
Plastic: Mixed	PL7	Combinations of plastics resins
Plastic: Other	PL9	Other types of plastics not coded #1-#7
Other Consumer Items	MIS	Consumer products not elsewhere classified
Miscellaneous	MIS	Materials not elsewhere classified

The categories shown in Table 1-2 accounted for 16 percent of all recycling data reported for the Commonwealth in 2001.

It should be noted that mixed paper and mixed plastic are valid and marketable grades of processed recyclables. For example, between ten and fifteen percent of all recovered paper that is consumed by paper mills nationally is purchased and consumed as a grade of mixed paper. Additional information on what is contained in these mixed grades can only be obtained by sorting recovered material.

Table 1-3 shows the amounts of "mixed" material for certain categories that are processed by materials recovery facilities in the Commonwealth.

Table 1-3
Size of "Mixed" Categories Processed by MRFs (2001 Tons)

Category	Curbside	Drop-Off	Commercial	Total
Commingled Materials	140,638	54,464[1]	57,871	252,972
Glass: Mixed	6,932	1,564	3,052	11,548
Paper: Mix	62,023	10,316	125,554	197,893
Plastic: Mixed	2,718	1,501	9,272	13,491
Total	**212,311**	**67,845**	**195,749**	**475,904**

[1] Includes 46,303 tons that was added by the DEP as a special line item to account for additional Recycling Performance Grant tons.

As the table shows, Commingled Materials and Mixed Paper contribute most heavily to the totals. The total amount of material that was reported in "mixed" categories in the Commonwealth in 2001 was 1,300,000 tons, approximately 600,000 tons of which was miscellaneous items such as additional scrap metal estimate, ash recycling, metals recovered from ash, and asphalt. Focusing on the above categories of materials for this study during the second period of MRF sorts, therefore, was thought to provide significant information on mixed materials reported in the Commonwealth.

R. W. Beck also analyzed the annual recycling database to determine which counties report the greatest amount of mixed materials. The result of the analysis is shown in Table 1-4 on the following page.

Table 1-4
Largest County Contributors to Reported Mixed Categories (2001 Tons)

	Commingled		Mixed Paper		Mixed Glass		Mixed Plastic	
	Res.	Com.	Res.	Com.	Res.	Com.	Res.	Com.
Allegheny County		18,546		6,636	2,903			619
Bucks County	10,382							2,259[1]
Centre County						1,000	663	
Chester County			7,721	8,885				
Dauphin County	10,883							2,132[1]
Delaware County			4,185					
Erie County		7,680					498	
Lackawanna County			7,200				439	743
Lancaster County	7,341			60,000				
Lehigh County	7,736	4,580						986
Montgomery County	11,922		30,773	5,395			780	
Philadelphia County	11,626			12,077				
Westmoreland County					351			
York County	7,913							
Subtotal	67,803	30,806	49,879	92,993	3,254	1,000	2,380	6,739
Commonwealth Total	140,637	57,871	72,339	125,554	6,931	3,052	4,219	9,272
Percentage of Total by Listed Counties	48%	53%	69%	74%	47%	33%	56%	73%

[1] Significantly different compared to 2000 data — data may be in error

Several of the counties listed in Table 1-4 are in the Southeast Region of the state (Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties), which suggested that a Philadelphia region MRF should be targeted for additional sorts. Also, the recyclables from Dauphin (Harrisburg), Lancaster, and York Counties listed in Table 4 are processed at the Recycle America York single-stream MRF. Although the Recycle America York MRF was included in the first period sort, it had only recently begun accepting single stream material and program changes in the three counties warranted a revisit to the MRF to obtain updated composition data. After analyzing the data in Table 1-4 and contacting MRFs to solicit their willingness to participate in the study, the following five MRFs were selected for the second period sorts:

1. **Blue Mountain Recycling** - a privately owned Philadelphia facility that processes two-stream recyclables from Montgomery and Philadelphia Counties;
2. **Lycoming County Resource Management Services** - a publicly owned and operated facility that processes curbside sort and drop-off recyclables from Lycoming County.
3. **Recycle America of York** - a privately owned single-stream facility that processes recyclables from Cumberland, Dauphin, Lancaster, and York Counties;

4. **Todd Heller, Inc.** - a privately owned facility that processes two-stream recyclables from Lehigh and Northampton Counties; and
5. **World Resources, Inc.** - a privately owned facility that processes two-stream recyclables from Erie County.

The Lycoming MRF did not report any mixed tons in 2001. It was included in the second sort period in order to obtain more sample data for curb-sort and drop-off systems.

1.3 Sort Methodology

Materials sorts were conducted between June and October, 2002 for the first sorting period and during March and April 2004 for the second sorting period. Three to four days were spent sampling material at each facility.

There are multiple steps to performing a sort as summarized below:

1. Send a data request to each MRF requesting days and hours of operation, incoming material quantities by type (e.g., drop-off, curb-sort, blue bag, commercial, etc.), processed quantities by grade, facility layout, and other operating data needed to finalize a MRF-specific sampling plan.
2. Conduct a site visit to each MRF to coordinate site logistics including sorting areas, mobile equipment and operator availability, and MRF health and safety requirements.
3. Prepare a sampling plan specific to each facility that includes the desired number and type of samples to be obtained from incoming deliveries, reject or residue ejection points, and recovered material.
4. Arrange for sort labor, which included a combination of R. W. Beck professionals, PROP members, and temporary personnel.
5. Conduct the sorts.

The remainder of this section describes the field data collection methodology that was employed during the study. Appendices A through I describe each of the host MRFs in greater detail.

1.4 Sampling and Sorting Protocol

There are three primary material streams associated with the recovery of recyclables that were analyzed as part of this study:

- Incoming loads of recovered materials;
- Rejects (contaminants) and process residues destined for disposal; and
- Recovered materials awaiting shipment to market.

Specific sampling and sorting techniques were employed depending on the material to be sorted and the condition of the material prior to sorting. A summary of sorting procedures is provided below:

- **Incoming Material Sorts—Drop-Off and Curb-Sort**: Typically each component in these multi-compartment truckloads was sequentially weighed and tipped on the floor where each material was sorted individually until the full load was sorted. Sorting of source-separated material primarily consisted of removing and weighing contaminants and then netting out the weight of these items from the overall compartment weight as provided by the MRF's truck scales.
- **Incoming Material Sorts—Dual Stream and Blue Bag**: Two samples were taken from dual stream collection vehicles, one from the paper compartment and one from the containers compartment. Sample target weights were 250 to 300 pounds, which were taken by a skid steer or other loader. Samples were either floor sorted or loaded onto a sort table for sorting. The mix of materials in a truck containing commingled containers includes both very dense materials (glass bottles) and very light materials (plastic bottles). When a truck dumps a load of commingled containers, glass tends to break and congregate in the center of the pile, while plastics "float" to the edges of the pile. Particular care was taken when selecting samples of commingled containers to ensure that the samples were representative of the entire load and not just a random scoop from a non-representative part of the pile.
- **Incoming Material Sorts—Single Stream**: Because all materials are collected together in a single compartment in single stream systems, only one sample was taken from each single stream load. A loader was used to take each 250 to 300 pound sample. Single stream material was sorted on a sort table, weighed and recorded on data forms.
- **Reject/Residue Sorts**: "Residue" is defined as that portion of acceptable recyclable materials that are not marketed due to spoilage, breakage, contamination, or simply because they are missed by the sorting process, but would have otherwise been recyclable. "Rejects" are defined as non-recyclable materials other than residue. Rejects and residues are normally ejected at several points during the processing of recyclables and the composition of rejects and residues varies significantly from one ejection point to another. For this reason, reject and residue samples were obtained from each primary ejection point in the MRF. Target sample weights were 200 pounds and material was sorted on a sort table. A screen was utilized to separate those larger items that are capable of being manually sorted from reject/residue material that is too small for separation (glass cullet and grit).
- **Processed Material Sorts—Loose**: Where possible, we attempted to obtain samples of processed material prior to baling, in which case sorting took place on the floor or on the sort table. Sample sizes were targeted for 250 to 300 pounds for processed paper and 200 pounds for processed plastics.
- **Processed Material Sorts—Baled**: If it was not possible to obtain a sample of loose processed material, representative bales of targeted processed material were placed on the floor and the bale wires cut to allow the baled material to expand. Based on the total weight of the bale, a 200 to 300 pound "slice" of material was taken from the bale, with lesser weights for plastics and higher weights for paper. In the case of voluminous materials such as plastic bottles and corrugated

containers, broken bales were floor sorted. Some paper grades were sorted via the sort table.

As was mentioned above, target weights for processed plastics and residue samples were somewhat lighter than for other samples. Because each plastic item or piece of residue weighs less on average than the other materials being sorted, less sample weight is needed to sample the same number of pieces. Even though data is recorded by weight, a sufficient number of pieces need to be sorted from each sample in order to ensure precision in the results.

1.5 Summary of Samples

Based on the pre-sort planning session that was held at each host facility prior to sorting, a sampling plan was developed for each of the host facilities to capture the maximum number of samples of each type using available sorter resources. Table 1-5 summarizes the samples that were taken at each facility.

Table 1-5
Sampling Summary

Host MRF	Number of Samples			Total
	Incoming Material	Reject/Residue	Processed Material	
Blue Mountain MRF	28	5	3	36
Centre County MRF	43	2	5	50
Lackawanna County MRF	8	3	5	16
Lycoming County MRF	31	3	4	38
Northern Tier MRF	32	2	3	37
Pittsburgh Recycling MRF	12	5	5	22
Recycle America York MRF (2002)	16[1]	3	4	23
Recycle America York MRF (2004)	29	2	5	36
Todd Heller MRF	33	2	3	38
World Resources MRF	30	4	2	36
Total	262	31	39	332

[1] Includes six samples from transfer trailers that were found to be non-representative of single stream collection. The materials in the transfer trailers had been collected in traditional dual stream collection vehicles, and partially mixed together at the point of transfer.

As Table 1-5 shows, a total of 332 samples were taken and sorted over the course of the project. Of the 262 incoming material samples, 231 were residential samples and 31 were commercial samples. Table 1-6 shows the materials that are accepted in the residential collection programs that were sampled as part of this study. As shown in Table 1-6, this study was successful at obtaining material samples from a wide geographic area encompassing all of the major recycling systems that are currently operational in Pennsylvania.

Table 1-6
Community Residential Collection Program Summary by Host Materials Recovery Facility

MRF and Municipality	Collection Program	Newspapers	Magazines	Corrugated Containers	Office/ Mail	Mixed Paper	Aluminum Cans	Steel Cans	3 Glass Colors	PET	HDPE	All Plastic Bottles
Blue Mountain Recycling												
Montgomery County (misc.)	Curbside	Y		Y			Y	Y	Y	Y	Y	
City of Philadelphia	Curbside	Y	Y	Y	Y	Y	Y	Y	Y			
Centre County Solid Waste Authority												
Council of Governments	Curbside	Y	Y	Y	Y		Y	Y	Y	Y	Y	
Harris Township	Curbside	Y	Y	Y	Y		Y	Y	Y	Y	Y	
Millheim Borough	Drop-off	Y		Y			Y	Y	Y	Y	Y	
Phillipsburg Borough	Drop-off	Y		Y			Y	Y	Y	Y	Y	
State College Borough	Curbside	Y	Y	Y	Y		Y	Y	Y	Y	Y	
Lackawanna County Solid Waste Authority												
Archibald Borough	Curbside	Y	Y				Y	Y	Y			Y
Dickson City Borough	Curbside	Y	Y	Y			Y	Y	Y			Y
Dunmore Borough	Curbside	Y	Y	Y			Y	Y	Y			Y
Jermyn Borough	Curbside	Y	Y				Y	Y	Y			Y
Moosic Borough	Curbside	Y	Y	Y			Y	Y	Y			Y
Olyphant Borough	Curbside	Y	Y	Y			Y	Y	Y			Y
City of Scranton	Curbside	Y	Y				Y	Y	Y			Y
Lycoming County Resource Management Services												
Williamsport	Curbside						Y	Y	Y			
Williamsport	Drop-off	Y	Y	Y			Y	Y	Y	Y	Y	
Northern Tier Solid Waste Authority												
Canton Borough	Curbside	Y					Y	Y	Y	Y	Y	
Eagles Mere Borough	Curbside-monthly	Y					Y	Y	Y	Y	Y	
Ridgebury Township	Drop-off- monthly	Y					Y	Y	Y	Y	Y	
Wyalusing Township	Drop-off- monthly	Y					Y	Y	Y	Y	Y	

MRF and Municipality	Collection Program	Newspapers	Magazines	Corrugated Containers	Office/ Mail	Mixed Paper	Aluminum Cans	Steel Cans	3 Glass Colors	PET	HDPE	All Plastic Bottles
Pittsburgh Recycling												
Bethel Park Borough	Curbside						Y	Y	Y	Y	Y	
Monroeville Borough	Curbside						Y	Y	Y	Y	Y	
Penn Hills Township	Curbside	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
City of Pittsburgh	Curbside	Y					Y	Y	Y	Y	Y	
Recycle America York												
Diller Transfer Station (Camp Hill)	Curbside	Y	Y	Y[1]			Y	Y	Y	Y	Y	
East Donegal Township	Curbside	Y	Y				Y	Y	Y	Y	Y	
City of Harrisburg	Curbside	Y					Y	Y	Y	Y	Y	
Harrisburg Transfer Station	Curbside	Y	Y[1]	Y[1]	Y[1]	Y[1]	Y	Y	Y	Y	Y	
Lancaster County Transfer Station	Curbside	Y	Y[1]				Y	Y	Y	Y	Y	
Palmyra Transfer Station	Curbside	Y	Y[1]	Y[1]								
Red Lion Borough	Curbside	Y	Y	Y	Y		Y	Y	Y	Y	Y	
Windsor Borough	Curbside	Y					Y	Y	Y	Y	Y	
York Township	Curbside	Y	Y				Y	Y	Y	Y	Y	
York Waste (Misc.)	Curbside	Y	Y[1]	Y[1]			Y	Y	Y	Y	Y	
Todd Heller, Inc.												
Allen Township	Curbside	Y	Y	Y			Y	Y	Y	Y	Y	
City of Allentown	Curbside	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Lehigh Township	Curbside	Y		Y			Y	Y	Y	Y	Y	
Monroe County (Misc.)	Curbside	Y					Y	Y	Y	Y	Y	
Northampton Borough	Curbside	Y					Y	Y	Y	Y	Y	
Pen Argyl Borough	Curbside	Y	Y	Y			Y	Y	Y	Y	Y	
Whitehall Township	Curbside	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
World Resources, Inc.												
City of Erie	Curbside	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Waste Management (Misc.)	Curbside	Y	Y	Y[1]	Y[1]	Y[1]	Y	Y	Y	Y	Y	

[1] Not all communities

Source: DEP Municipal Recycling Programs database

Section 2
INCOMING MATERIALS COMPOSITION

2.1 Introduction

The data provided herein are useful and illustrative of the differences in average material composition between different types of recycling collection styles and different types of MRFs. However, it must be noted that significant variation was observed among samples taken from communities that utilize the same style of collection and processing and request the same materials. Some of the community attributes that are thought to contribute to this variation include:

- Urban, suburban, or rural — newspapers are larger in urban and suburban regions compared to rural regions;
- Collection and processing system — subtle differences in recycling education and collection and processing systems and equipment can cause significant differences in glass breakage (mixed color cullet), contamination levels, and whether paper is marketed as mixed or sorted grades;
- Regional influences — depending on the region, milk may be sold almost exclusively in natural HDPE jugs or it may be sold in white or yellow pigmented HDPE juts; similarly, regional influences can influence the relative proportions of brown versus green glass from beer bottles; and
- Socioeconomic influences — wealthier communities tend to have a higher preponderance of green glass from wine bottles and residents are more likely to subscribe to more than one newspaper.

The data in this section may prove useful to solid waste planners. However, because of community-to-community variations, it should not be relied upon as a substitute to gathering local composition data, particularly when such data is to be used for MRF design or as part of a recycling services request for proposals.

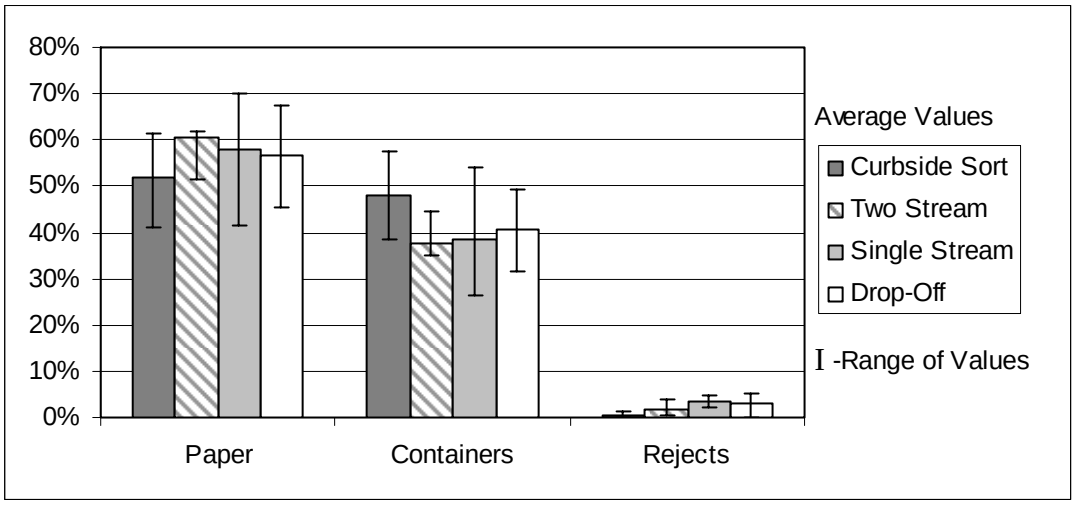
2.2 Composition of Incoming Residential Materials

2.2.1 Paper, Containers, and Rejects Proportions

Figure 2-1 compares the relative proportions of paper, containers, and rejects[4] in incoming residential recyclables based on the type of collection program.

[4] In the context of incoming materials delivered by residential recycling collection trucks, rejects are those materials that are not targeted for recovery. Examples include contaminated/non-recyclable paper, plastic bags, #3-#7 plastic bottles, non-bottle plastic containers, non-container rigid plastic, non-container ferrous metals, non-ferrous metals other than aluminum cans and aluminum foil, organic materials, and other inorganic or multi-material products.

Figure 2-1
Composition of Incoming Residential Recyclables



As the range of values in Figure 2-1 shows, the relative proportions of paper and containers varied significantly from sample-to-sample. However, the average values of the different collection styles were quite similar, except for curbside sort, which showed a lower proportion of paper and higher proportion of containers compared to the other collection styles. Two factors are thought to contribute to this difference:

- Curbside sort collection vehicles can normally accommodate up to eight sorts at the curb. MRFs serving curbside sort systems often are not designed with the capability of performing additional sorting, so often only a limited number of materials are collected[5] and paper such as corrugated containers, junk mail, and residential mixed paper may not be included in the program.
- Curbside sort collection systems are often utilized in rural areas because low recovery volumes are an obstacle to making costly capital expenditures for commingled material sorting systems. Because the major component of the paper stream is newspaper, it is likely that the size and distribution frequency of the local newspaper contributes significantly to the variation from community to community of the relative proportions of paper and containers. Newspapers are smaller in rural communities compared to newspapers in metropolitan areas.

Throughout this report numerical averages are included in tables for the graphical data that are illustrated by the figures. This is done for the benefit of solid waste planners who are attempting to split or otherwise estimate the composition of mixed recyclables. Consideration should always be given to the range of values observed and local factors that could make a community's composition different from the average. Table 2-1 presents the average composition values of incoming residential recyclables that correspond to Figure 2-1.

[5] Many curbside sort recycling systems accept newspapers, clear glass, amber glass, green glass, aluminum cans, steel cans, PET plastic bottles, and HDPE plastic bottles.

Table 2-1
Composition of Incoming Residential Recyclables

Collection System	Paper	Containers	Rejects
Curb-Sort	51.7%	47.9%	0.4%
Two-Stream	60.7%	37.6%	1.8%
Single Stream	58.0%	38.4%	3.7%
Drop-Off	56.6%	40.5%	3.0%

Rejects were found to be lowest in curbside sort programs at 0.4 percent. This is not surprising since the collector of the material has the opportunity to provide ongoing education at no expense about which recyclables are not accepted in the program by leaving rejects in the collection bin. The highest average levels of rejects were found in drop-off and single stream collection programs, with reject levels at 3.0 and 3.7 percent, respectively. While the average reject level in two-stream collection systems was 1.8 percent, many samples had reject levels that were comparable to reject levels in the average drop-off program. Also, some drop-off samples had reject levels that were lower than the average curb-sort system.

Identifying factors that contribute to increased reject levels was beyond the scope of this project. However, other Pennsylvania studies have demonstrated that reject levels in drop-offs can be as low as that of curbside sort systems if the drop-offs are properly designed and if public education is performed. Schuylkill County, while not part of this study, provided data that supports this assertion. Schuylkill County used to operate a roll-off container based drop-off system where contamination averaged 5.5 percent. After converting to a Haul-All drop-off system and reemphasizing public education, contamination levels fell to 0.5 percent. It should be noted that none of the drop-off programs included in this study utilized the Haul-All system, which is in use by thirteen counties in Pennsylvania. The drop-off composition data presented in this study, therefore, should not be considered to be representative of drop-offs using the Haul-All system, particularly in regards to reject levels in the incoming materials.

2.2.2 Residential Paper Composition

Figure 2-2 and Table 2-2 compares the relative proportions of paper products and rejects found in incoming residential paper.

Figure 2-2
Composition of Incoming Residential Paper by Collection System Type

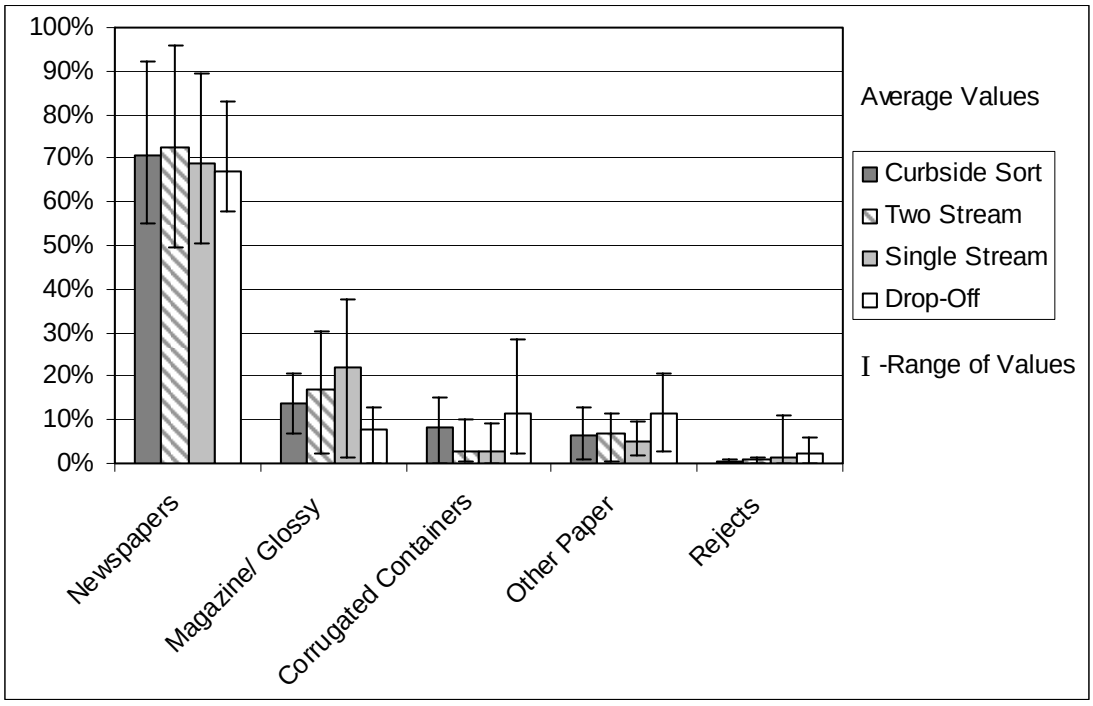


Table 2-2
Average Composition of Incoming Residential Paper by Collection System Type

Collection System	Newspapers	Magazines/ Glossy	Corrugated Containers	Other Paper	Rejects
Curbside Sort	70.9%	13.9%	8.5%	6.5%	0.2%
Two-Stream	72.7%	17.1%	2.7%	6.9%	0.7%
Single Stream	68.9%	22.2%	2.7%	5.0%	1.2%
Drop-Off	67.0%	7.7%	11.4%	11.4%	2.4%

As the range of values in Figure 2-2 show, the composition of individual samples of incoming paper was found to vary significantly depending on the size of the local newspaper and, more importantly, depending on the materials requested by the local recycling programs. For example, some collection programs targeted only newspapers, while others targeted all kinds of uncontaminated residential paper. For this reason it is important to note that some program operators will consider their paper rejects to be higher than shown in Figure 2-2 and Table 2-2 because they receive recyclable paper (magazines, corrugated containers, printing and writing paper, etc.) that they did not target in their recycling education programs and which ultimately may be disposed by the MRF.

The type of collection system utilized is perhaps not the best indicator of incoming residential paper composition. Figure 2-3 and Table 2-3 show the composition of incoming residential paper based on the materials accepted in individual recycling programs.

Figure 2-3
Composition of Incoming Residential Paper by Paper Program Type

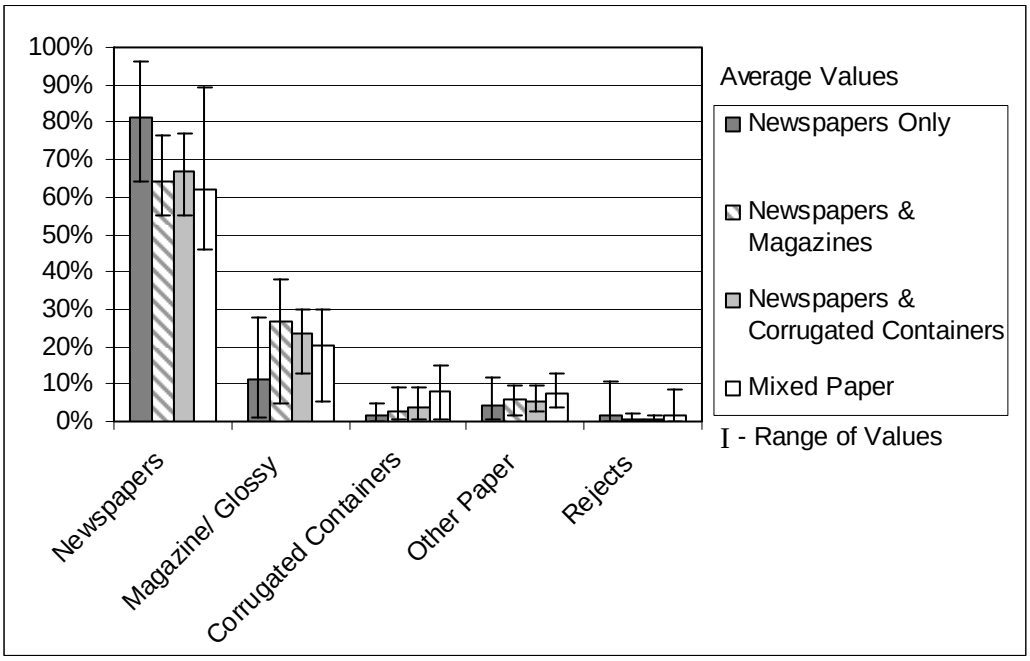


Table 2-3
Average Composition of Incoming Residential Paper by Paper Program Type

Paper Program	Newspapers	Magazines/ Glossy	Corrugated Containers	Other Paper	Rejects
Newspapers Only	81.2%	11.2%	1.7%	4.4%	1.5%
Newspapers and Magazines	64.1%	26.6%	2.6%	6.0%	0.6%
Newspapers and Corrugated Containers[1]	66.6%	23.4%	3.6%	5.6%	0.8%
Mixed Paper[2]	62.1%	20.5%	7.9%	7.7%	1.8%

[1] Some communities also include magazines.
[2] At a minimum includes newspapers, magazines, corrugated containers, and office paper/junk mail. Some communities include all forms of uncontaminated paper.

As Figure 2-3 and Table 2-3 show, the percentage of newspapers decreases as additional types of paper are added to the collection program. It is worthy to note that newspaper only programs do not have the lowest level of rejects.

According to the National Recycling Coalition, magazines and catalogs are not recycled as often as they could be for several reasons, including:

- Some consumers think glossy paper is a contaminant in paper recycling; and
- Magazines are dense, heavy and slick and may difficult for some residents to stack, bundle or bag at the curb.

The City of Boston and Prince George's County, Maryland are partnering with the National Recycling Coalition, TiPaper Co., Time Inc., and International Paper to increase magazine recycling in their communities using a new magazine recycling

education and awareness campaign titled ReMix. ReMix is an acronym made from **Re**cycling **M**agazines **i**s E**x**cellent. Although the results of the new campaign were not complete as of this project, R. W. Beck performed additional sorts of glossy paper during the second sorting period to provide an estimate of the program's potential in Pennsylvania. The additional sorts separated what otherwise would have been a combined magazine/glossy category into two separate categories, one for subscription magazines and the second category for glossy catalogs and other glossy paper (primarily glossy newspaper inserts). The results of the subsorts are shown in Figure 2-4 and Table 2-4.

Figure 2-4
Proportions of Subscription Magazines and Glossy Paper in Incoming Paper

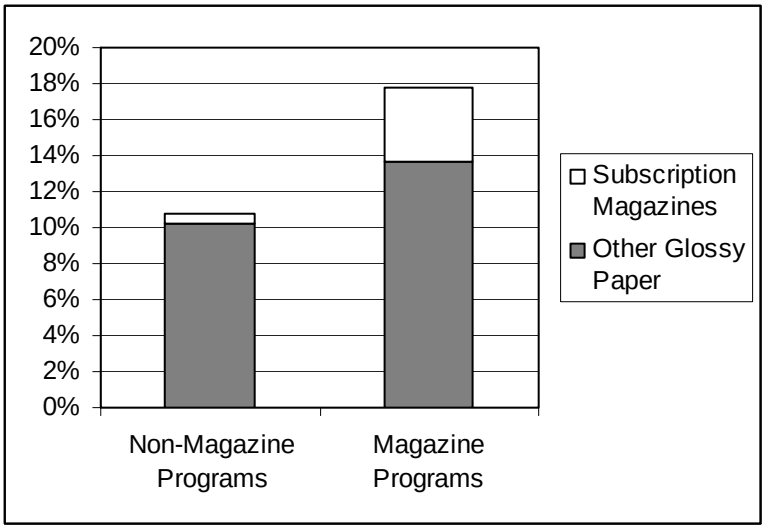


Table 2-4
Proportions of Subscription Magazines and Glossy Paper in Incoming Paper

Paper Program	Subscription Magazines	Other Glossy Paper	Total Magazines and Glossy Paper
Non-Magazine Programs	0.6%	10.2%	10.8%
Magazine Programs[1]	4.1%	13.6%	17.8%

[1] Programs may also accept corrugated containers, office paper/junk mail, or all forms of uncontaminated paper.

Figure 2-4 and Table 2-4 show that Pennsylvania communities that include magazines in their recycling programs have significantly greater percentages of magazines and glossy paper in their recovered paper than communities who do not include magazines. On a tonnage basis, the difference is even more pronounced than depicted Figure 2-4 and Table 2-4 because some of the Pennsylvania communities included in the magazine program statistics also accept corrugated containers or all forms of residential mixed paper, which reduces the percentages of magazines and glossy paper in the overall recovered paper totals.

2.2.3 Residential Containers Composition

Figure 2-5 and Table 2-5 compare the relative proportions by major material type of incoming residential containers and rejects. Significant variation was seen among the container proportions for individual samples as the ranges of values show. Significant variation is also seen between the average proportions of glass containers, plastic bottles, steel cans, and aluminum cans when comparing the different collection system types. When computing the averages, only data for communities that targeted all four materials in their recycling programs were included, so the differences cannot be attributed to some programs not accepting glass or plastics and there is no other readily apparent cause for the differences.

Figure 2-5
Composition of Incoming Residential Containers

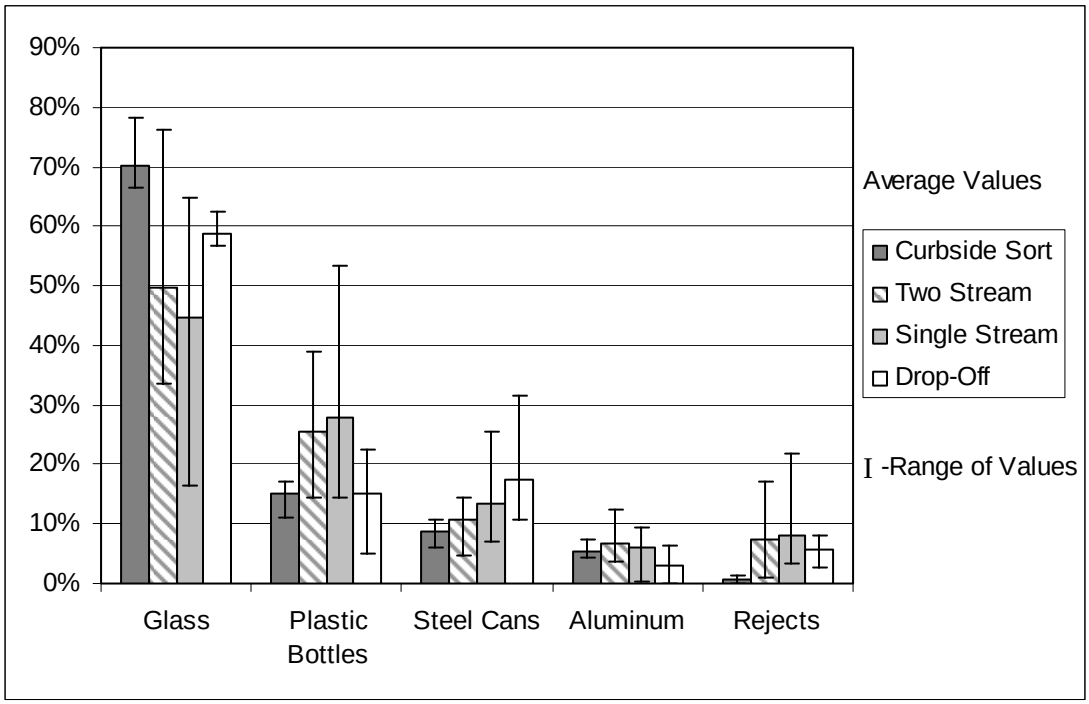


Table 2-5
Average Composition of Incoming Residential Containers

Collection System[1]	Glass	Plastic Bottles	Steel Cans	Aluminum[2]	Rejects
Curbside Sort	70.2%	15.1%	8.8%	5.3%	0.6%
Two-Stream	49.8%	25.3%	10.6%	6.7%	7.4%
Single Stream	44.6%	27.9%	13.4%	5.9%	8.1%
Drop-Off	58.8%	15.0%	17.6%	3.1%	5.6%

[1] Table only reflects data from communities that accept all four container materials in their programs.
[2] Includes cans, food tins, and foil.

Figure 2-6 and Table 2-6 provide additional detail on the composition of incoming plastic bottles.

Figure 2-6
Composition of Incoming Plastic Bottles

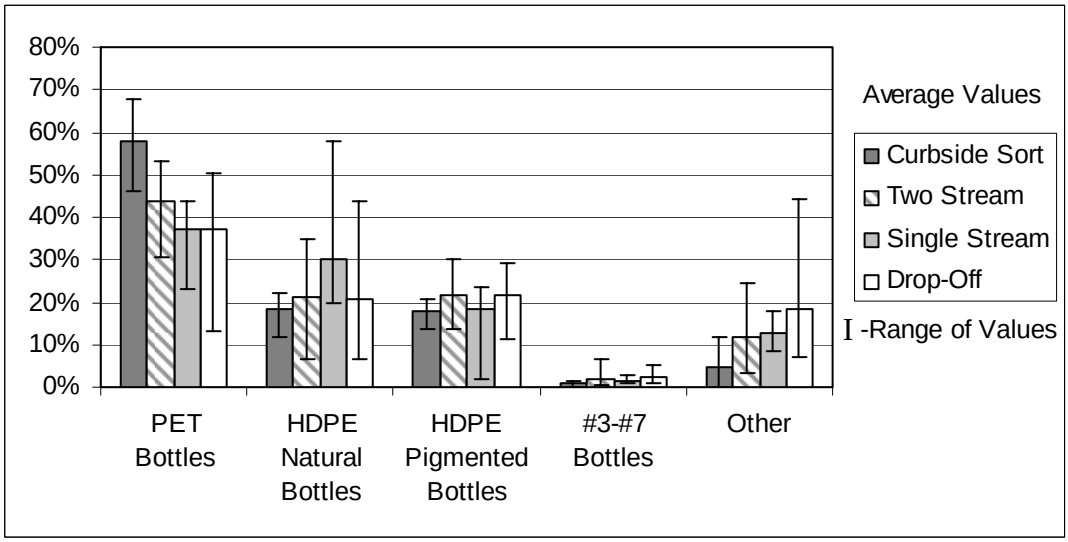


Table 2-6
Average Composition of Incoming Plastic Bottles

Collection System	PET Bottles	HDPE Natural Bottles	HDPE Pigmented Bottles	#3-#7 Bottles	Other Materials[1]
Curbside Sort	57.9%	18.5%	18.0%	0.8%	4.8%
Two-Stream	43.8%	21.1%	21.5%	1.9%	11.7%
Single Stream	37.4%	30.2%	18.3%	1.6%	12.6%
Drop-Off	37.0%	20.8%	21.7%	2.2%	18.3%

[1] Includes non-bottle plastics for all collection systems and plus non-plastics for incoming separated loads (curbside sort and drop-off).

Figure 2-6 and Table 2-6 show that contamination by other materials (i.e., bags, non-bottle plastics, non-plastic items) far outweighs the amount of #3-#7 bottles that are received. Often, #3-#7 bottles receive much of the attention when the issue of plastics contamination is discussed.

During the first period of sorts R. W. Beck also sorted plastic bottles based on contents into beverage and non-beverage categories. Beverage bottles were also sorted by size into single serving (<= 24 ounces) and multiple serving (>24 ounces) sizes. There is a concern that single service beverage bottles face recovery challenges and the results of this study, when coupled with disposal or generation data, can shed light on this issue. The results of these subsorts are shown in Figure 2-7 and Table 2-7.

Figure 2-7
Contents and Size Comparison of Incoming Plastic Bottles

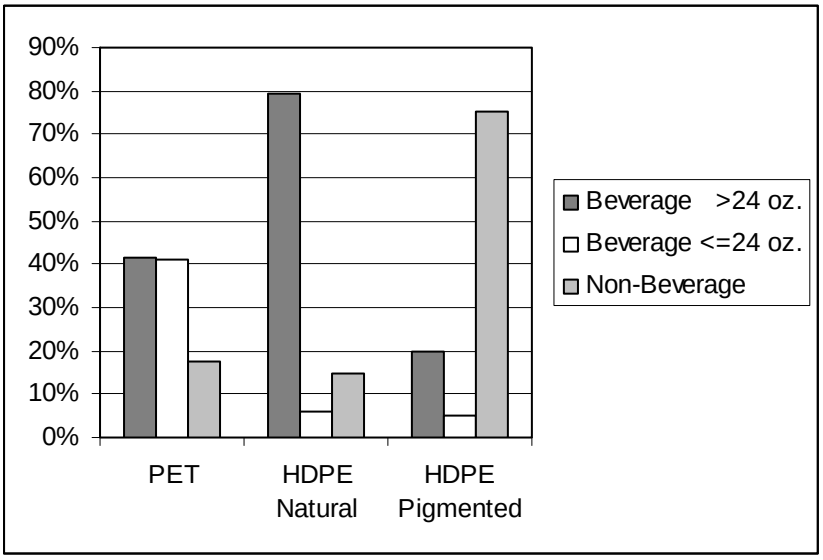


Table 2-7
Contents and Size Comparison of Incoming Plastic Bottles

Size and Contents	PET Bottles	HDPE Natural Bottles	HDPE Pigmented Bottles
Beverage >24 oz.	41.4%	79.3%	19.6%
Beverage <=24 oz.	41.1%	5.8%	4.9%
Non-Beverage	17.5%	14.9%	75.4%

Figure 2-7 and Table 2-7 show that small PET beverage bottles are nearly equal in weight to the amount of large PET beverage bottles recovered.

Glass containers were sorted in this project into subcategories of clear, green, amber, and mixed color cullet. Figure 2-8 and Table 2-8 show the composition of incoming glass containers by color, excluding the effect of mixed color cullet.

Figure 2-8
Color of Incoming Glass Containers

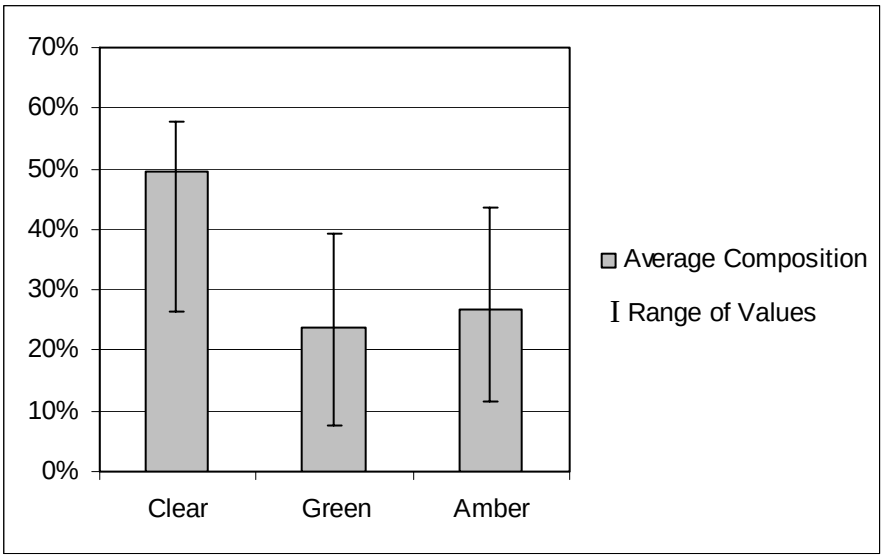


Table 2-8
Color of Incoming Glass Containers

	Clear	Green	Amber
Glass Containers[1]	49.7%	23.7%	26.6%

[1] Sortable glass, excluding mixed color cullet.

Figure 2-8 and Table 2-8 show that clear glass is predominant, followed by amber and then green glass. The large range of values should be noted in Figure 2-8, indicating that color composition varied widely among all the samples. It is thought that the color mix of glass at the local level is highly dependent on local socio-economic factors and product consumption patterns. In particular, green glass from wine and beer bottles can cause differences in the color mix depending on local consumption patterns. Caution should therefore be taken before applying these composition results on the local level.

The color mix of sortable incoming glass containers can also be impacted by the degree of glass breakage that occurs in the collection system. Large clear glass jars that have held mayonnaise and other food products are thinner and break more easily than thicker wall bottles that have held beer or wine. This can cause the fraction of sortable clear glass containers to be less than depicted above in collection systems where glass breakage is elevated. Figure 2-9 and Table 2-9 shows the percentage of glass containers that were received as mixed color cullet from the collection systems included in this study.

Figure 2-9
Proportion of Mixed Cullet in Incoming Glass Containers

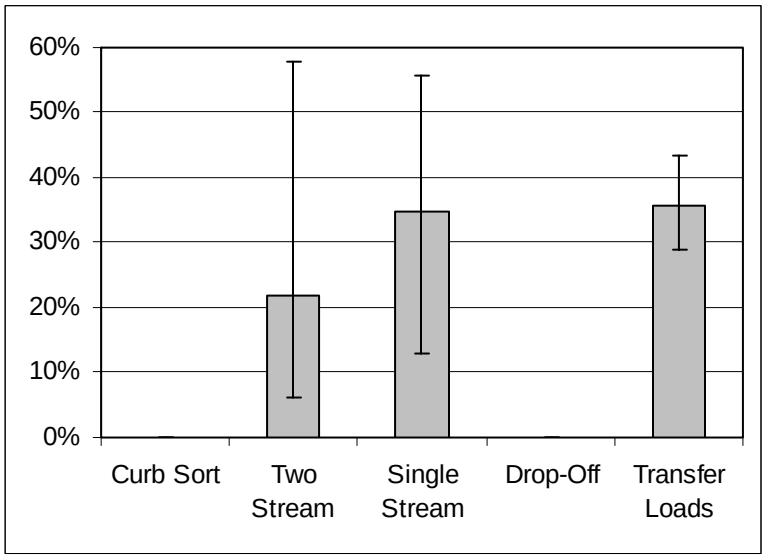


Table 2-9
Proportion of Mixed Cullet in Incoming Glass Containers

	Curb-Sort	Two-Stream	Single Stream	Drop-Off	Transfer Loads
Mixed Glass Cullet	0.0%	21.9%	34.9%	0.0%	35.7%

As Figure 2-9 and Table 2-9 show, the greatest percentage of mixed cullet in incoming glass containers occurs in single stream collection systems and in loads of transferred recyclables. Collection of single stream recyclables is often accomplished using compacting vehicles. The additional handling associated with loading and unloading recyclables for transfer over long distances is thought to result in the higher breakage found in transfer loads. It should be noted that in commingled recyclables systems, additional breakage also occurs after being received at the MRF due to additional mechanical manipulation of recyclables by loaders and the sorting system.

2.2.4 Composition Profiles for Incoming Mixed Residential Recyclables

A primary objective of this study was to produce composition data that could be used to estimate the composition of residential recyclables that have been recovered and are reported as mixed. Composition profiles are provided in this section for residential commingled containers, and residential single-stream recyclables. As was noted previously, individual community composition results often show significant variation from community-to-community. For that reason, the profiles shown in this section should be considered to be Commonwealth averages and should not be relied upon to represent the composition of a particular community's recovered material.

Table 2-10 shows the composition of incoming single-stream recyclables that are processed at the Recycle America single-stream MRF in York.

Table 2-10
Composition of Incoming Residential Single Stream Recyclables

Category	Composition
Newspapers	45.7%
Glossy Paper (inserts)	7.6%
Magazines (subscription)	1.8%
Corrugated Containers	1.4%
Office Paper	0.5%
Phone Books	0.7%
Mixed (Other Recyclable) Paper	1.3%
Subtotal Paper	*58.9%*
#1 PET Bottles	5.0%
#2 HDPE Bottles	6.9%
Clear Glass	7.0%
Green Glass	3.5%
Amber Glass	3.7%
Mixed Cullet	7.2%
Steel Cans	5.6%
Aluminum Cans	2.0%
Aluminum Other	0.2%
Subtotal Containers	*41.1%*
Total	100%

Table 2-10 shows the composition of incoming residential recyclable materials in categories that correspond to DEP reporting categories. Glossy paper was primarily newspaper inserts, which are normally included and reported as newspapers as it does not have a separate DEP reporting category. The composition data shown in Figure 2-10 is after the removal of contaminants, which was 3.6 percent of the incoming single-stream material. It is important to note that recyclable material is also lost during processing, which is not reflected by the above figures (overall, the facility reported that 9.5 percent of all incoming commercial, single-stream, and two-stream recyclables processed by the facility is disposed as residue).

The figures shown in Table 2-10 were derived by averaging the compositions of incoming single-stream material from several collection programs both inside and outside of York County, including recyclables delivered by transfer trailer from Lancaster, Palmyra, and Diller (Camp Hill) transfer stations. A simple average was used because annual data for individual programs was not available for calculating a weighted average. It should be noted that material that was delivered in two-stream fashion and material transferred in from Harrisburg was not included in computing the average composition shown above.[6]

It is important to note that most collection programs that supplied material to the Recycle America single-stream MRF accepted only newspapers, and in come cases magazines, at the time this study was conducted. This is different than many single-stream programs found elsewhere that accept a broad range of paper, which may limit

[6] Harrisburg material was excluded because of the low percentage of newspapers in the transferred material, which is thought to be a consequence of not collecting newspapers in the past. Harrisburg data and data from two-stream programs were excluded in order to present composition estimates that could be expected for an "average" single-stream program.

the use of the above profile to material processed by the Recycle America MRF in York.

Figure 2-11 shows the average composition of residential containers processed by eight of the MRFs included in this study that accept commingled containers.

Table 2-11
Composition of Incoming Residential Commingled Containers

Category	Composition
#1 PET Bottles	12.9%
#2 HDPE Bottles	12.4%
Clear Glass	21.9%
Green Glass	11.9%
Amber Glass	12.9%
Mixed Cullet	9.6%
Steel Cans	11.7%
Aluminum Cans	6.4%
Aluminum Other	0.4%
Total	100%

The composition data shown in Figure 2-11 is for incoming residential material after the removal of contaminants, which was 7.2 percent of the incoming containers stream. It is important to note that recyclable material is also lost during processing, which is not reflected by the above figures. For example, it can be difficult to market mixed cullet and often that material becomes residue.

The figures shown in Table 2-11 were derived by averaging the compositions of incoming containers from various communities that supply each individual MRF. The containers compositions for each of the eight MRFs that accept commingled containers were then averaged to produce the composition estimates shown in Table 2-11.

2.3 Composition of Incoming Commercial Materials

Although this project was primarily focused on MRFs that process residential recyclables, many of those facilities also process commercial recyclables as well. The most common commercial recyclables accepted include office paper and corrugated containers. This study took commercial recyclables samples from each of those streams of materials. Because mixed metals are processed by scrap metal yards rather than MRFs, no mixed metal samples were sorted as part of this study.

Figure 2-10 and Table 2-12 show the composition of incoming paper from corrugated container and office paper collection routes.

Figure 2-10
Composition of Incoming Commercial Paper

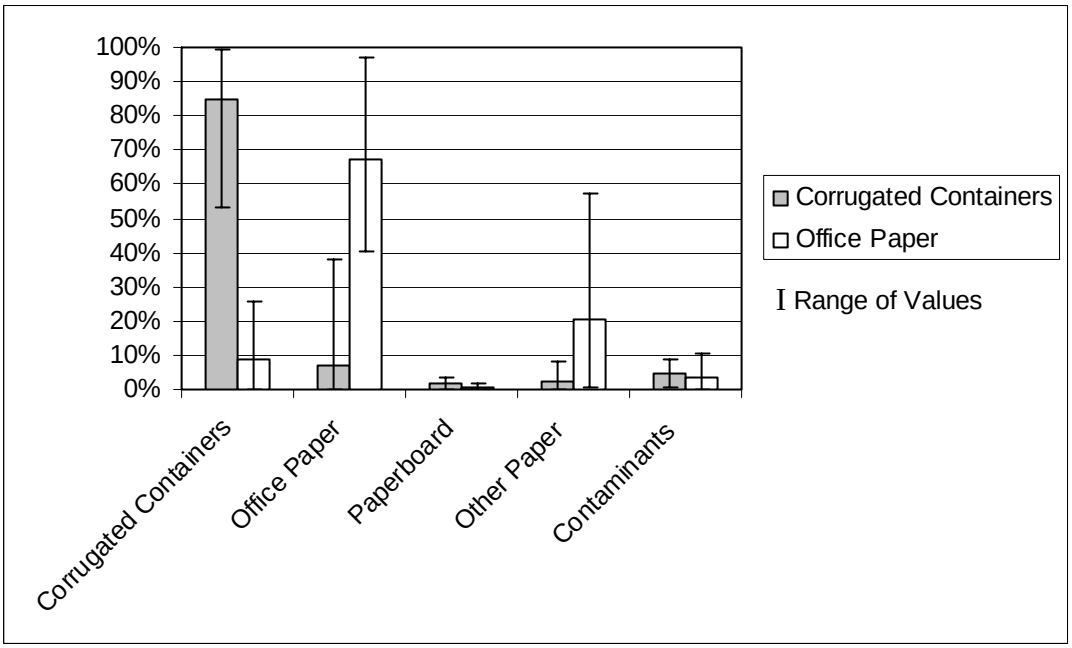


Table 2-12
Average Composition of Incoming Commercial Paper

Collection Route	Corrugated Containers	Office Paper	Paperboard	Other Paper	Contaminants
Corrugated Containers	84.5%	7.0%	1.7%	2.4%	4.4%
Office Paper	8.5%	67.2%	0.8%	20.3%	3.3%

As the range of values in Figure 2-10 shows, some collection routes for corrugated containers and office paper only accept those specific materials; alternatively, other collection routes will accept a broader range of paper, particularly if the MRF is able to sort paper into different grades.

3.1 Introduction

This report section presents composition information on materials that have been processed to market specifications. As was mentioned previously, some recycling markets purchase materials as a mixed grade. Because only paper and occasionally plastics are shipped to end use markets in mixed form, only paper and plastics were sorted for processed material composition. The other materials (aluminum cans, steel cans, clear glass, green glass, and amber glass) were assumed to include only insignificant mixtures of other recyclable materials or contaminants.

3.2 Processed Paper

Figure 3-1 and Table 3-1 show the composition of processed newspaper:

Figure 3-1
Composition of Processed Newspaper

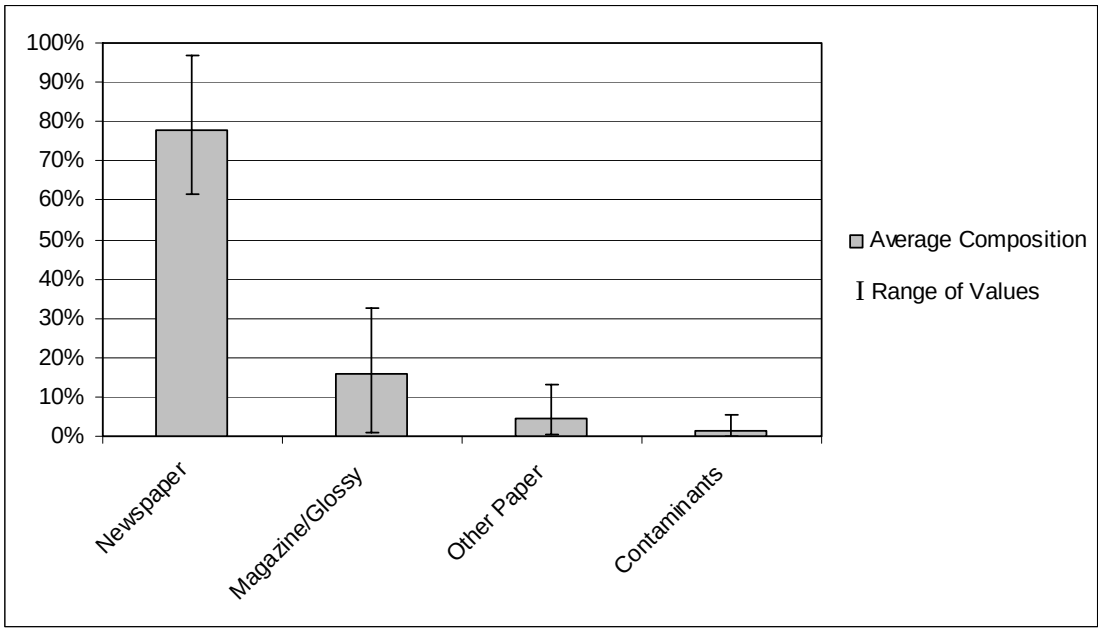


Table 3-1
Average Composition of Processed Newspaper

Newspaper	Magazines/Glossy	Other Paper	Contaminants
77.8%	16.1%	4.7%	1.5%

As Figure 3-1 shows, in some cases the processed newspaper was almost exclusively newspaper, whereas in other cases it contained almost 40 percent magazines and other

paper. As shown in Table 3-1, the average composition of newspaper in what was being called processed newspaper was 77.8 percent. The reason for the large variation depends on what individual paper mills consider to be contaminants. Paper mills that use a clay deinking technology generally accept magazines in their newspaper because the clay coating on glossy magazine stock aids in their deinking process. Mills that use different deinking technologies generally don't accept magazines in their newspaper bales. Two grades of newspaper are also commonly sold and the price difference between #6 and #8 newspaper grades (and other paper grades such as mixed paper) can also affect the average composition as MRFs adjust their processing based on market price and demand for different paper grades.

Figure 3-2 and Table 3-2 show the composition of processed corrugated containers.

Figure 3-2
Composition of Processed Corrugated Containers

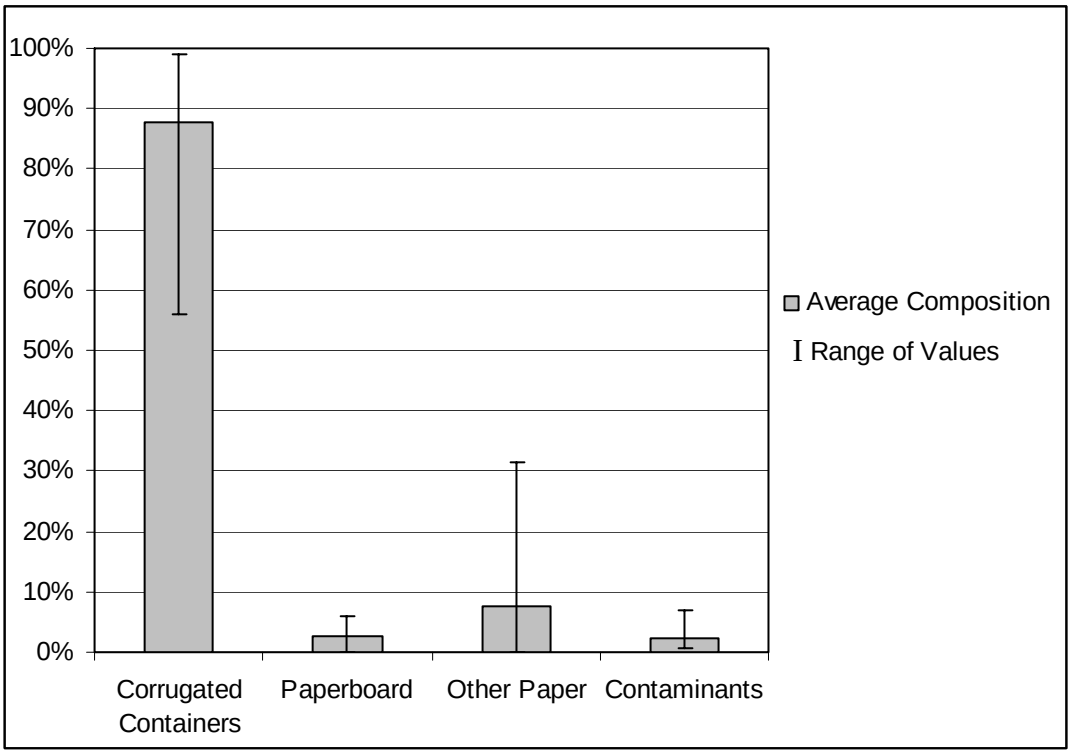


Table 3-2
Average Composition of Processed Corrugated Containers

Corrugated Containers	Paperboard	Other Paper	Contaminants
87.8%	2.5%	7.5%	2.2%

Similar to processed newspaper, Figure 3-1 and Table 3-2 show that processed corrugated containers varied significantly in composition and often was not exclusively corrugated containers. A reason for the large variation depends on what individual paper mills consider to be contaminants. Paper mills that produce

paperboard have a greater tolerance for other grades of paper in OCC bales than do paper mills that produce linerboard for use in making recycled content corrugated containers. In reviewing the samples that were sorted, publicly owned and managed facilities produced processed OCC that was almost exclusively OCC. Alternatively, the privately owned and operated MRFs produced grades of processed OCC that contained significant levels of other paper.

Figure 3-3 and Table 3-4 show the composition of processed office paper.

Figure 3-3
Composition of Processed Office Paper

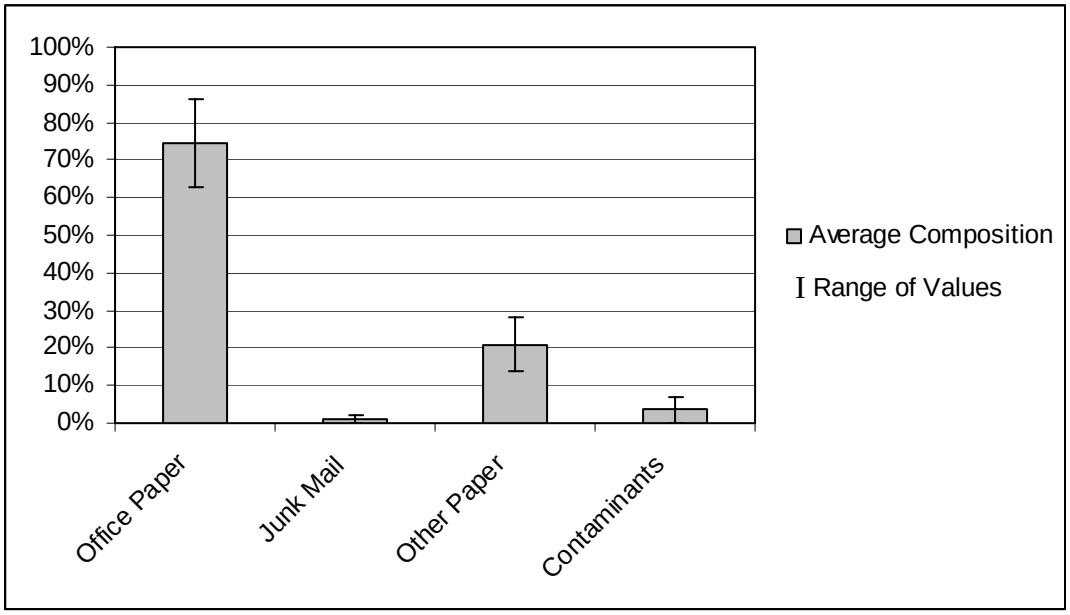


Table 3-3
Average Composition of Processed Office Paper

Office Paper	Junk Mail	Other Paper	Contaminants
74.5%	1.1%	20.9%	3.6%

The other paper depicted in Figure 3-3 and Table 3-3 includes glossy/catalogues, newspaper, and other forms of recyclable paper. It should be noted that the data shown in Figure 3-3 and Table 3-3 are derived from only two samples and therefore may not be representative of processed office paper in the Commonwealth.

3.3 Processed Plastics

Figure 3-4 and Table 3-4 show the composition of processed PET bottles.

Figure 3-4
Composition of Processed PET Bottles

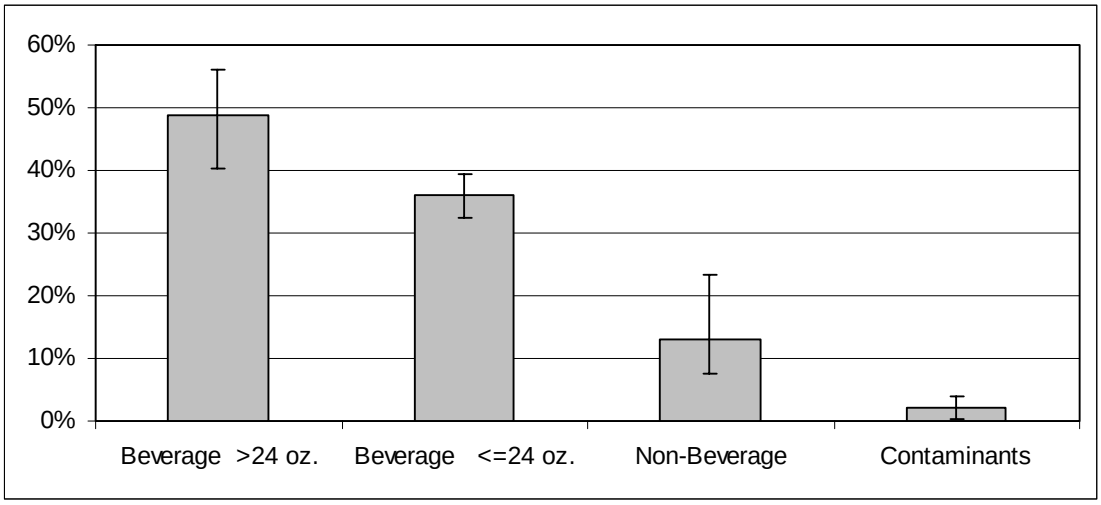


Table 3-4
Average Composition of Processed PET Bottles

Beverage >24 oz.	Beverage <=24 oz.	Non-Beverage	Contaminants
48.8%	35.9%	13.0%	2.2%

As Figure 3-4 and Table 3-4 show, beverage containers composed 85 percent of processed PET bottles.

Figure 3-5 and Table 3-5 show the composition of processed natural HDPE bottles.

Figure 3-5
Composition of Processed Natural HDPE Bottles

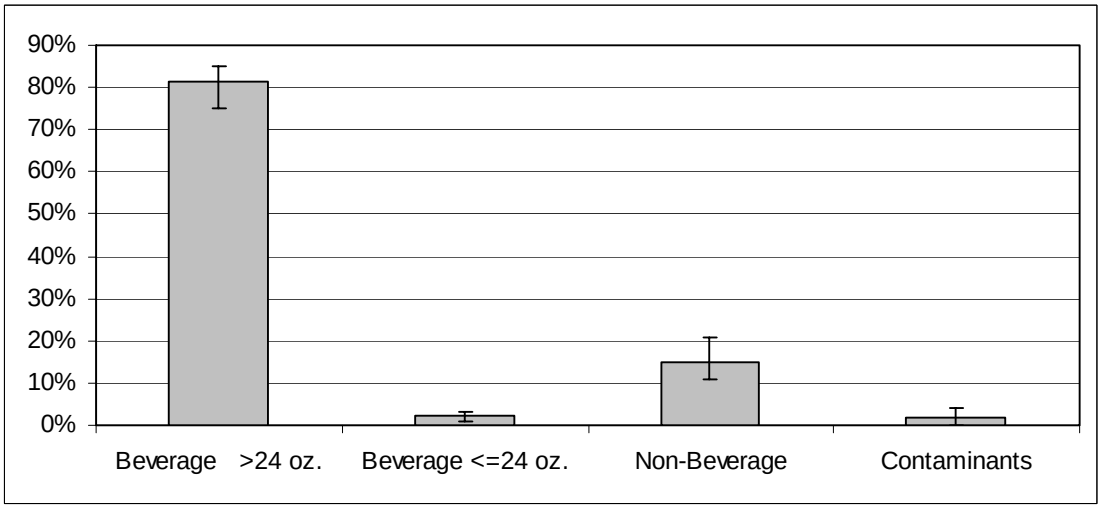


Table 3-5
Average Composition of Processed Natural HDPE Bottles

Beverage >24 oz.	Beverage <=24 oz.	Non-Beverage	Contaminants
81.3%	2.3%	14.8%	1.8%

As Figure 3-5 and Table 3-5 show, the majority of processed natural HDPE bottles are large beverage bottles, primarily milk jugs.

Figure 3-6 and Table 3-6 show the composition of processed pigmented HDPE bottles.

Figure 3-6
Composition of Processed Pigmented HDPE Bottles

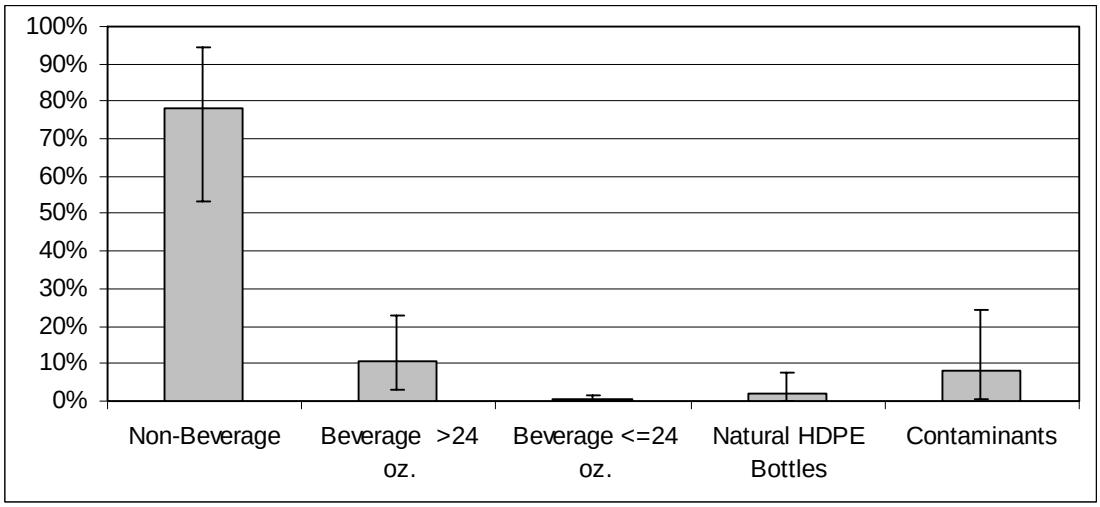


Table 3-6
Average Composition of Processed Pigmented HDPE Bottles

Non-Beverage	Beverage >24 oz.	Beverage <=24 oz.	Natural HDPE Bottles	Contaminants
78.3%	10.6%	0.7%	2.1%	8.2%

As Figure 3-6 shows, there was a large degree of variation in this grade of processed material among the facilities. At one facility, "HDPE pigmented bottles" are negatively sorted, meaning that after PET and HDPE natural bottles have been positively sorted out the pigmented bottles and whatever else remains on the plastics sort line are baled together. While the "contaminants" in baled HDPE pigmented bottles from this facility were high, they were largely composed of non-bottle plastics that perhaps could be acceptable in the stream provided the material goes to a plastic lumber producer. The MRFs also varied significantly in the >24 ounce beverage category. Two of the facilities are in regions of the state where yellow or white pigmented milk jugs are sold in significant quantities. It should be noted that natural HDPE bottles are not considered to be a contaminant to pigmented HDPE bottles.

Section 4
REJECTS AND RESIDUES

4.1 Introduction

"Rejects," in the context of processing, are what the MRFs (as defined by their markets) regard as contaminants and which they by practice separate for disposal from a recovered material stream, such as film bags and wet newspaper. When discussing residues[7] in the context of processing, this report uses that term to describe materials that are negatively discharged from one or more points in the processing lines. Residue often includes significant quantities of desired recyclables that were either missed on the sorting line or that became uneconomical to recycle, such as glass containers that became broken mixed color cullet. Both "rejects" and "residues" terms can therefore include both materials that are commonly considered to be "recyclable" as well as materials that may commonly be considered to be "contaminants."

Normally, MRFs have more than one ejection point for rejects and residues. Sometimes there are several ejection points. Depending on what incoming stream of material is being processed on a multi-purpose processing line (e.g., curbside paper, curbside containers, drop-off, commercial paper) the composition of rejects and residues can vary significantly at any given ejection point over the course of a processing day. The result is that determining the overall composition of materials disposed by a MRF is a complex undertaking that requires doing a mass balance at the facility and taking multiple samples of rejects and residues at each ejection point when processing differing incoming streams of material. Such an undertaking was not a primary objective of the project and was beyond the project scope. Instead, this report gives composition results for individual samples taken from various ejection points at the MRFs that were included in this study.

4.2 Reject and Residue Samples

Figure 4-1 shows "snapshot" compositions of each individual reject and residue sample that was taken for this study.

[7] Residues are strictly defined to be desired materials that are ultimately disposed by the MRF because of collection or processing equipment limitations or operating practices. Frequently, the term "residues" is loosely used to collectively describe all materials (both rejects and residues) that are disposed by MRFs. This report does not use the term "residues" in this sense.

Figure 4-1
Composition of Reject and Residue Samples

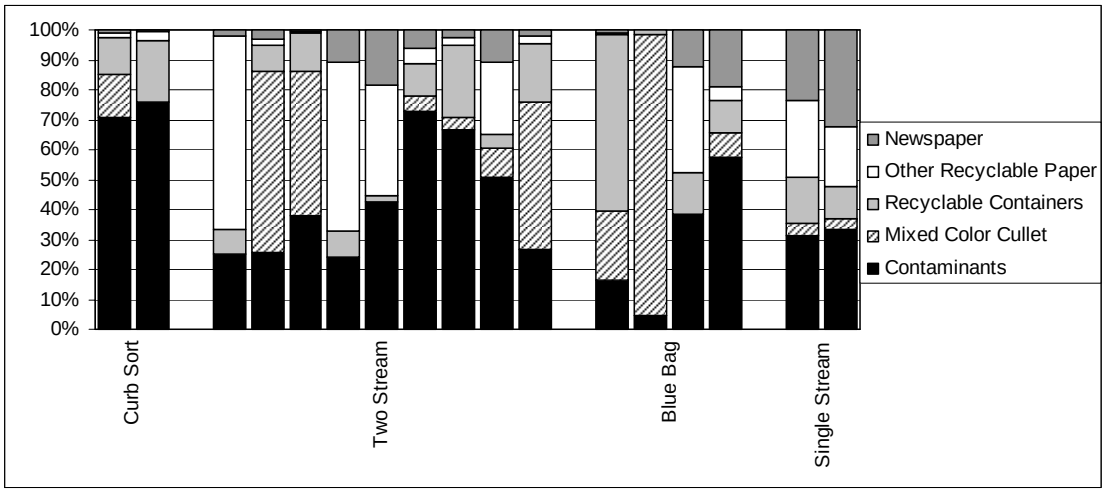


Figure 4-1 shows that reject and residue streams from curb-sort systems are primarily composed of contaminants – relatively few desired recyclables are disposed. Alternatively, as more commingling occurs, greater percentages of desired recyclables are lost at reject or residue ejection points and are ultimately disposed. The report appendices that follow provide descriptions of the processing equipment and operating practices at each MRF that lead to giving each reject and residue stream the composition it has. In that context, an understanding can be obtained of why certain desired recyclables are ultimately disposed.

4.3 Plastics Rejects and Residues

Due to some marked differences in the composition of incoming verses processed plastic bottles, R. W. Beck further analyzed the size and type of plastic bottles found in the reject and residue samples and compared the result to the incoming and processed material compositions. The results of this analysis are shown for PET bottles, natural HDPE bottles, and pigmented HDPE bottles in Figures 4-2, 4-3, and 4-4 respectively.

Figure 4-2
Composition of PET Bottles in Incoming,
Processed, and Reject and Residue Streams

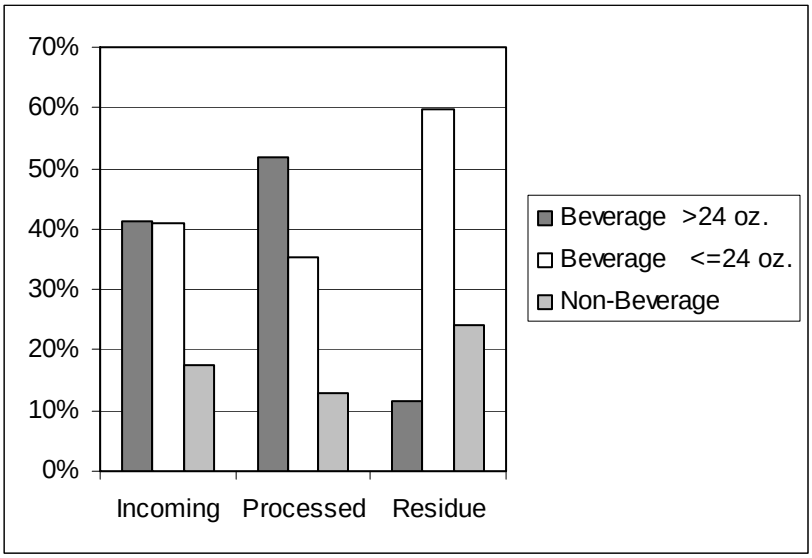


Figure 4-3
Composition of Natural HDPE Bottles in Incoming,
Processed, and Reject and Residue Streams

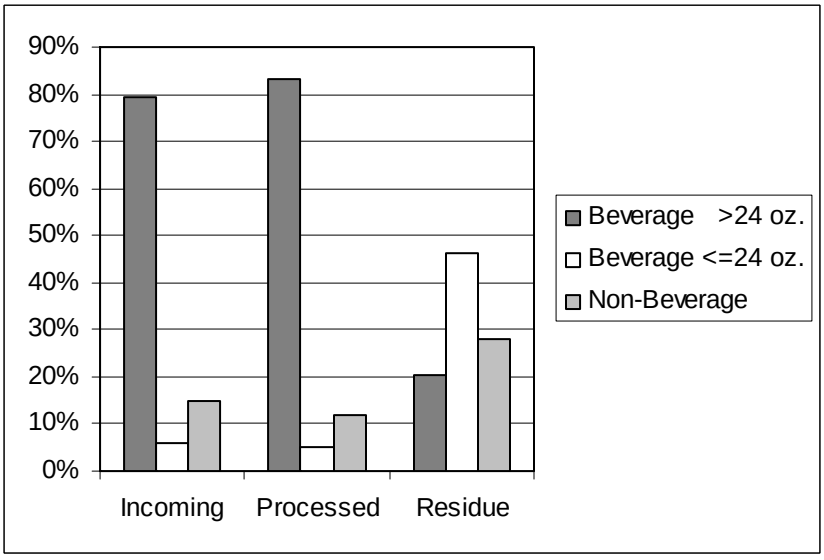
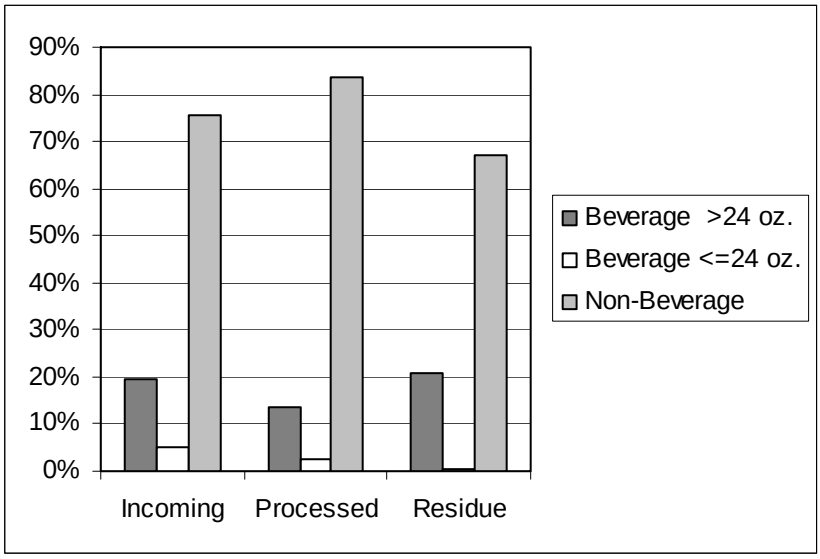


Figure 4-4
Composition of Pigmented HDPE Bottles in Incoming, Processed, and Reject and Residue Streams



The most pronounced difference between incoming and processed material was observed for PET bottles. Figure 4-2 shows that single serve PET bottles were nearly equal to large PET bottles on entering the MRFs but were on average significantly less in the processed material. They also were the most prevalent type of PET bottles found in rejects and residues. This data demonstrates that significant numbers of small PET beverage bottles are missed on the sorting lines and go off the sorting belt as residue.

Marked shifts in composition of natural and pigmented HDPE bottles were not observed, as Figures 4-3 and 4-4 show, indicating that fewer of those bottle types were missed on the sorting lines.

Section 5
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This study had two primary objectives:

- Provide insight on the composition of residential and commercial recyclables that are collected and processed across Pennsylvania from a wide range of collection program types and materials recovery facility processing configurations; and
- Develop recyclables composition data that can then be used by communities and/or the Pennsylvania Department of Environmental Protection to estimate recyclables amounts by material type that otherwise would be reported as mixed recyclables.

Both of these objectives were met by this study.

This study is unique in that no other state has quantified the composition of incoming and processed recyclables and residue streams in MRFs as comprehensively as the DEP has done through this study. Furthermore, as a state on the forefront recycling public policy, the DEP included additional subsorts of paper and plastic bottles that have led to several conclusions that are of national significance. These conclusions are:

- Promoting the recycling of subscription magazines not only leads to the recovery of magazines — it also boosts the recovery of other glossy paper as well.
- Collecting recyclables single stream can lead to an increased level of rejects in the incoming material. Incoming material reject levels at the single stream MRF included in this study were two percent higher than in two-stream MRFs.
- Collecting recyclables single stream can lead to an increased level of mixed color cullet in the incoming material. Incoming glass that was received as mixed color cullet was 35 percent at the single stream MRF compared to 22 percent at the two-stream MRFs. However, it is important to note that less cullet was disposed by the single stream MRF compared to two-stream MRFs because the single stream MRF separates and sends its cullet to market.
- Nearly equal amounts of small and large PET beverage bottles are received by the MRFs included in this study. However, a significant percentage of the small bottles are missed on the sorting lines and are disposed as residue.

5.2 Recommendations

The DEP should encourage the inclusion of magazines in community recovery programs in the Commonwealth.

A national trend is the conversion of two-stream collection and processing systems to single stream systems. To the extent that this trend proceeds in Pennsylvania, the DEP

will need to revisit the single stream composition results as they are only derived from one MRF in one part of the state.

R. W. Beck observed that the four publicly owned and operated MRFs included in the study appeared to produce processed paper that was of higher quality than the five privately operated MRFs. It is surmised that the MRFs incur a higher processing cost to produce the higher quality materials. It is not known whether they receive better marketability and prices for their higher quality recyclables. The DEP should continue to support MRFs with technical assistance to help them minimize processing costs while meeting the quality standards that are required by markets.

APPENDICES

Appendix A
BLUE MOUNTAIN RECYCLING CENTER

A.1 Collection and Processing Overview

The Blue Mountain Recycling Center processes residential dual stream, commercial corrugated containers and mixed office paper recyclables from a range of sources including the City of Philadelphia, commercial haulers, and recyclables shipped by transfer trailer from other communities in Pennsylvania and New Jersey. Table A-1 provides a summary of the relative amounts of materials that that the facility receives from Philadelphia compared to other jurisdictions.

Table A-1
Incoming Material Summary

	Average Tons from City of Philadelphia	Average Tons from Surrounding Counties & NJ	Total Incoming Tons
Annual Tons[1]	6,000	4,000	10,000

[1] As reported by Blue Mountain Recycling. Additional detail regarding relative amounts of incoming materials was considered proprietary information by Blue Mountain Recycling and was not provided for this study.

As Table A-1 shows, the majority of the recovered materials that are processed by the facility are generated in the City of Philadelphia (the City). The City of Philadelphia collects residential recyclables using a dual stream bi-weekly curbside collection system. Residential mixed paper, excluding OCC, is one stream and commingled metal and glass containers make up the second stream. Philadelphia's curbside recycling program accepts the following materials:

- Mixed paper that is set out in a paper bag or tied with string, including:
  - Newspapers including inserts;
  - Junk mail;
  - Envelopes with or without windows;
  - Telephone books;
  - Magazines;
  - Catalogs;
  - Paperboard boxes with removed liners such as cereal, cookie, cracker, cake mix, and gift boxes;
  - Home office paper; and
  - Stationery and other clean paper.

- Commingled containers, including:
  - Steel cans;
  - Aluminum cans;
  - Empty aerosol/paint cans; and
  - Glass bottles and jars.

The City does not collect plastic bottles in its curbside program; instead it collects plastic bottles (water, milk, juice, soda bottles labeled #1 or #2) and mixed paper, including OCC, through a separate drop-off system.

The following processing takes place at the facility:

- **Tip Floor:** All incoming material is tipped on a central tip floor and pushed into an appropriate pile on separate areas of the tip floor depending on the type of incoming material. The four types of incoming materials are commingled containers, residential mixed paper (primarily old newspapers — ONP), mixed paper, and OCC, which is dumped in a bunker just outside the tip floor area.
- **Manual Commingled Sort:** The commingled containers are pushed onto a conveyor, which feeds an elevated sorting platform. The sort employees positively sort the glass, plastics, and metals from contaminates. All sorted materials are stored in separate holding bunkers for future baling except for the glass, which is further processed (crushed) as described below.
- **Manual Fiber Sorting:** On the fiber side of the facility residential paper (primarily ONP), OCC, and mixed (office) paper are pushed at separate times onto an incline conveyor leading to an elevated sorting platform. Each stream of fiber material is negatively sorted and proceeds directly to the baler after removal of non-conforming paper materials are stored in bunkers below for later baling (as a different paper grade) and contaminants are disposed.
- **Baling:** The facility includes several balers. Depending on the processing line, several methods are used to get the materials from the storage bunkers to the baler.

Details of the commingled container sortation process are provided below.

- Glass is manually separated from the mixed containers (without further color sorting) and is deposited into a single bunker with a feed conveyor that moves the glass to a glass crusher. The three color mix crushed glass is stored in a bunker outside the building until it is ready to be shipped to market;
- Aluminum cans are separated next on the conveyor by an eddy current machine and are stored in a bunker until ready to be baled;
- An overhead magnet removes ferrous metals that are deposited in a container; and
- Plastic bottles (PET, HDPE natural, and HDPE pigmented) are manually removed last and are left mixed rather than being sorted into different resin categories. The plastic bottles are dropped into a specialized cage for storage until baling.

Details of the fiber sortation process are provided below.

- Primary fiber grades are ONP and OCC, which are manually sorted (negative sort) and feed directly into a baler;
- Positively sorted fibers that are manually removed from the primary fiber streams (kraft bags, OCC or mixed office paper) are stored in bunkers and are later baled;
- Other contaminants are stored in bunkers for disposal.

A.2 Sampling Summary

A four-day sampling and sorting event was conducted at the Blue Mountain Recycling Center from March 16-19, 2004. The objective of the sampling event was to investigate the composition of materials as they are received and processed by the Recycling Center. Three specific material streams were included in the sampling and sorting activities:

- Incoming materials from both residential and commercial generators;
- Processed (recovered) materials, such as newspaper and OCC; and
- Residues and contaminants that were ejected from various points along processing lines at the facility.

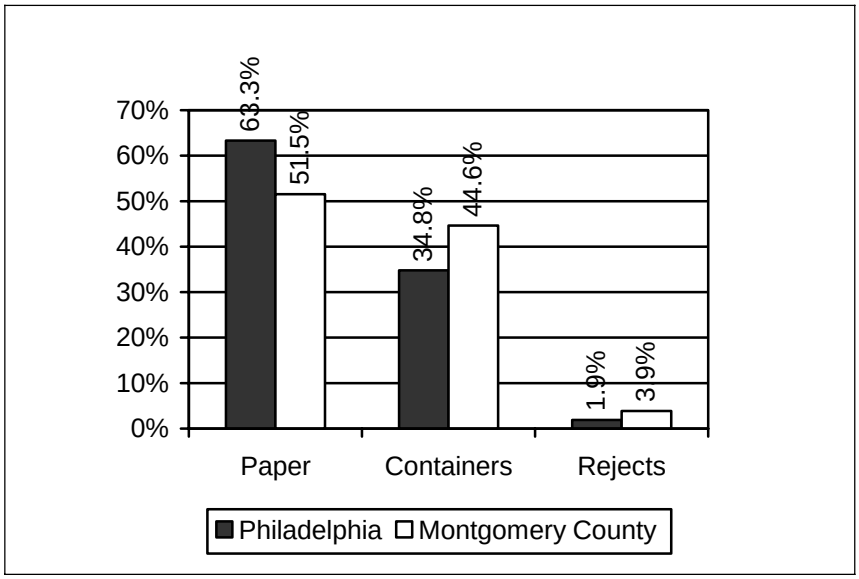
Material samples were taken from each of these three streams using techniques designed to assure that the samples would be representative. Incoming material samples included a representative "scoop" of material. Processed material samples were either taken from broken bales, from the end of conveyor belts, or from material storage containers in the MRF. Residues and contaminants were taken similarly from appropriate ejection points in the facility. Sample sizes were targeted for 250 to 300 pounds.

This study intended to obtain samples primarily from incoming materials, with several samples reserved for processed materials and rejects and residues. This sampling plan was selected to provide the best statistical confidence on composition data from incoming material.

A.3 Composition of Incoming Materials

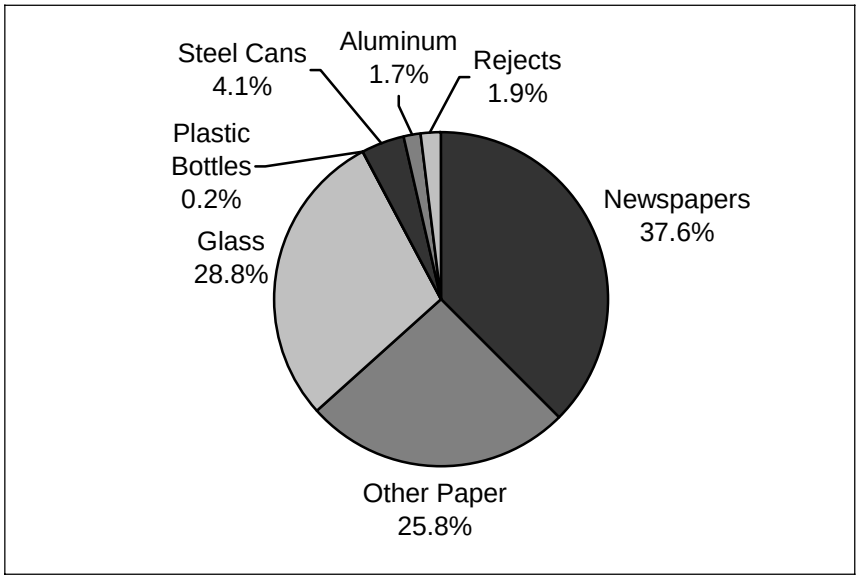
Figure A-1 compares the relative proportions of paper, containers, and rejects in incoming curbside-collected two-stream residential recyclables from Philadelphia and Montgomery County. When the two are compared, it should be noted that Philadelphia does not accept plastic bottles in its curbside recycling program, which results in lower containers and reject percentages than otherwise would be the case. Also, residential mixed paper is collected in Philadelphia, whereas many municipalities in Montgomery County only request newspapers including glossy inserts.

Figure A-1
Composition of Incoming Residential Recyclables



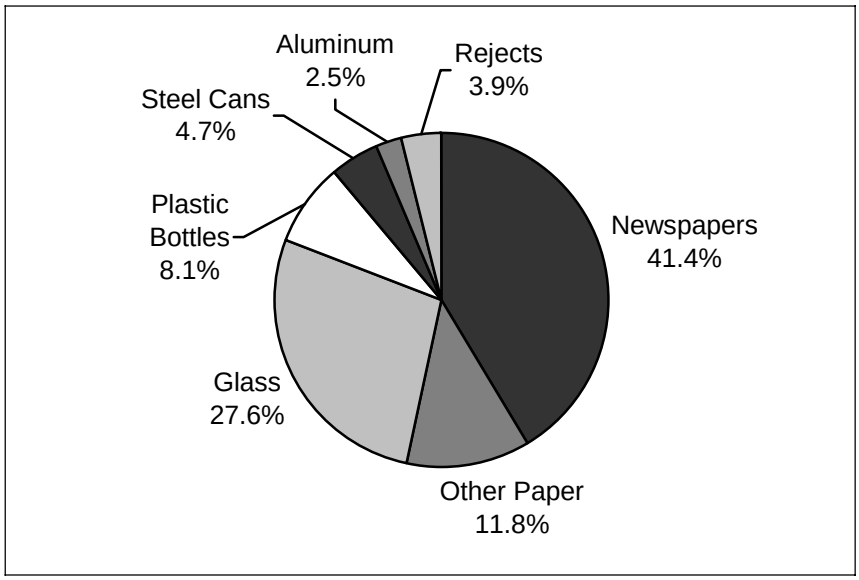
Figures A-2 and A-3 show additional detail on the composition of incoming two-stream curbside-collected residential recyclables from the City of Philadelphia and Montgomery County, respectively.

Figure A-2
Composition of City of Philadelphia
Incoming Two-Stream Residential Recyclables



Note: composition based on data from fourteen paper and containers samples

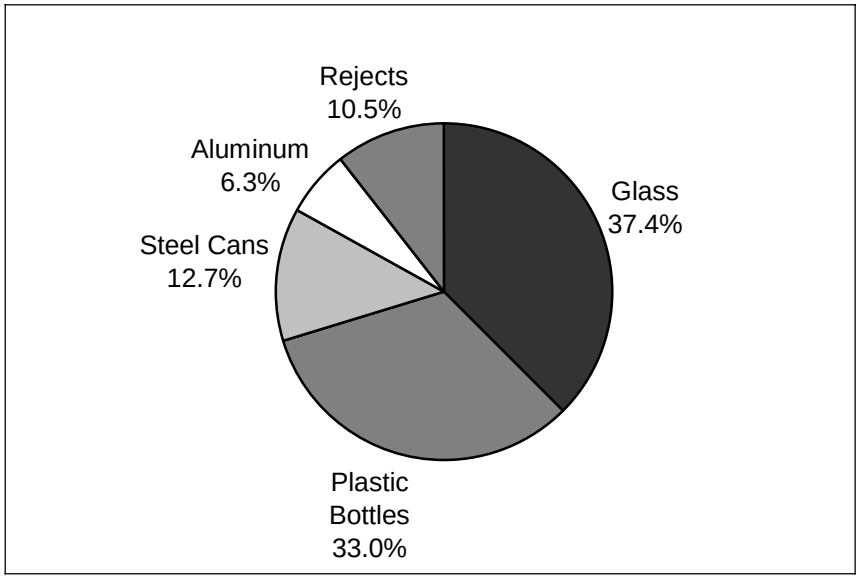
Figure A-3
Composition of Montgomery County
Incoming Two-Stream Residential Recyclables



Note: composition based on data from four paper and containers samples

In addition to receiving individual collection vehicle loads of recyclables from Montgomery County, the Blue Mountain Recycling Center receives transfer trailer loads of residential commingled containers as well. Figure A-4 shows the composition of those containers.

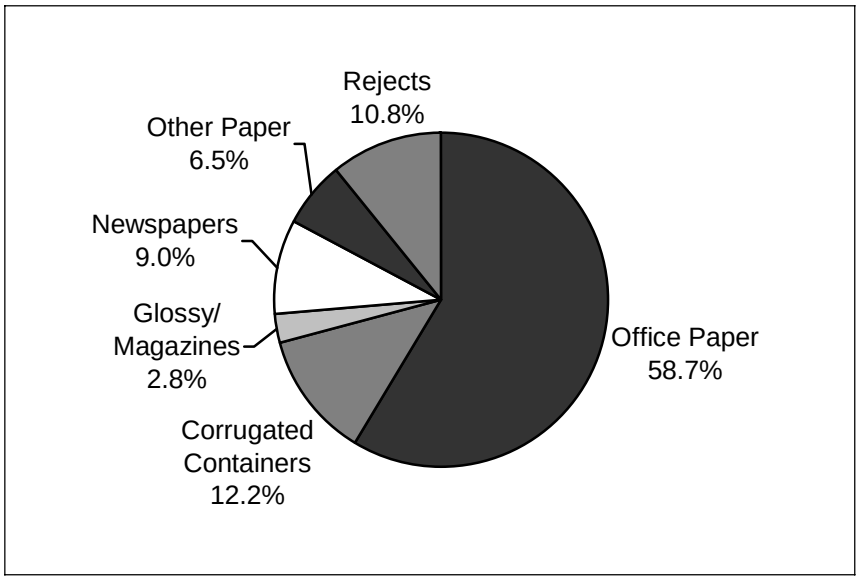
Figure A-4
Composition of Montgomery County Transferred Residential Containers



Note: composition based on data from three samples

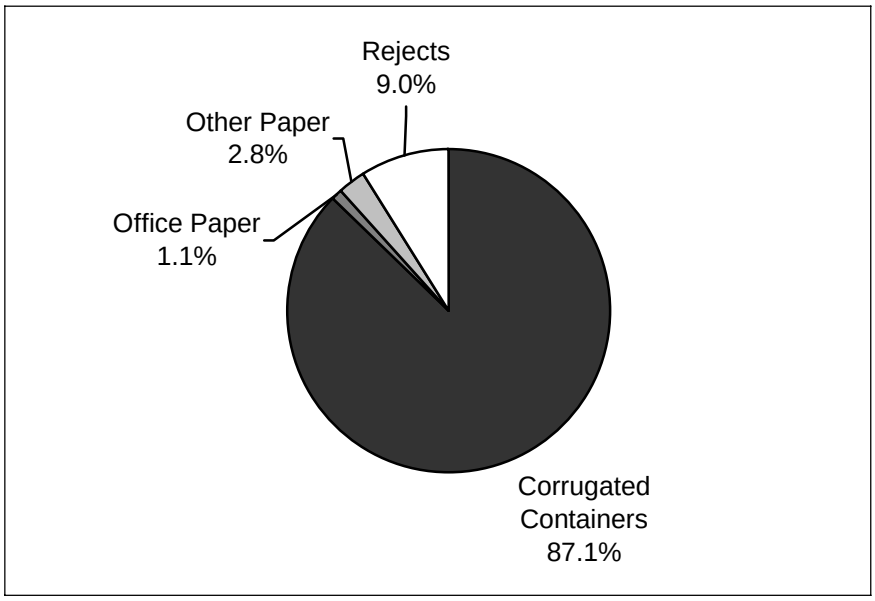
The Blue Mountain Recycling Center also processes commercial recyclables. Figures A-5 and A-6 show the composition of incoming office paper and corrugated container streams that are received by the facility.

Figure A-5
Composition of Incoming Office Paper



Note: composition based on data from three samples

Figure A-6
Composition of Incoming Commercial Corrugated Containers

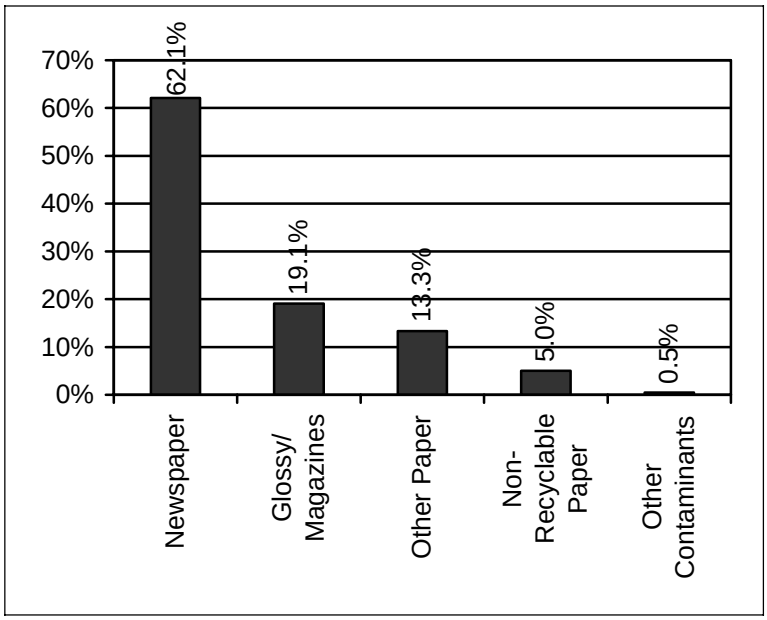


Note: composition based on data from three samples

A.4 Composition of Processed Recyclables

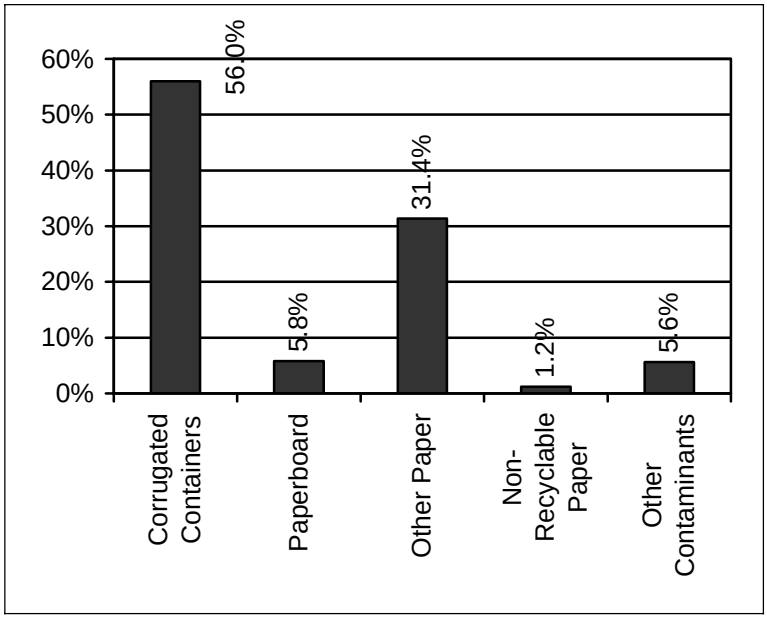
Figures A-7, A-8, and A-9 show the composition of processed newspaper, corrugated containers, and office paper.

Figure A-7
Composition of Processed Newspaper



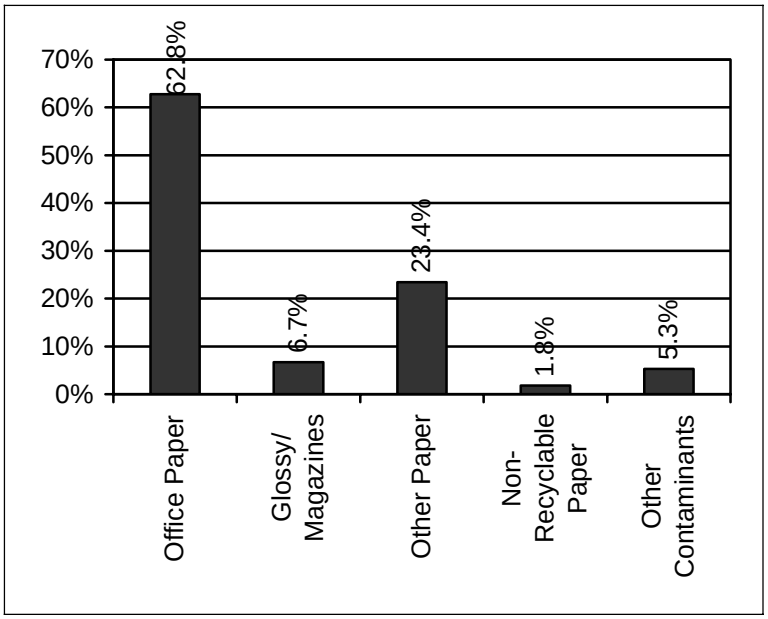
The Other Contaminants shown in Figure A-7 are ferrous metal and film bags.

Figure A-8
Composition of Processed Corrugated Containers



The Other Contaminants shown in Figure A-8 are non-bottle plastic containers, HDPE bottles, clear glass, steel cans, and organic materials.

Figure A-9
Composition of Processed Office Paper



The Other Contaminants shown in Figure A-9 are primarily ferrous metals, non-recyclable glass, and non-container rigid plastic.

The figures in this section show that some grades of paper may contain approximately 60 percent of the material that they are nominally sold and reported as.

A.5 Composition of Rejects and Residues

Paper sort line residues were sampled at two locations, the first being at a star screen while processing OCC, and the second at a manual contamination removal station while processing office paper. The composition of these samples is shown in Figures A-10 and A-11.

Figure A-10
Composition of Paper Sort Line Star Screen Residue

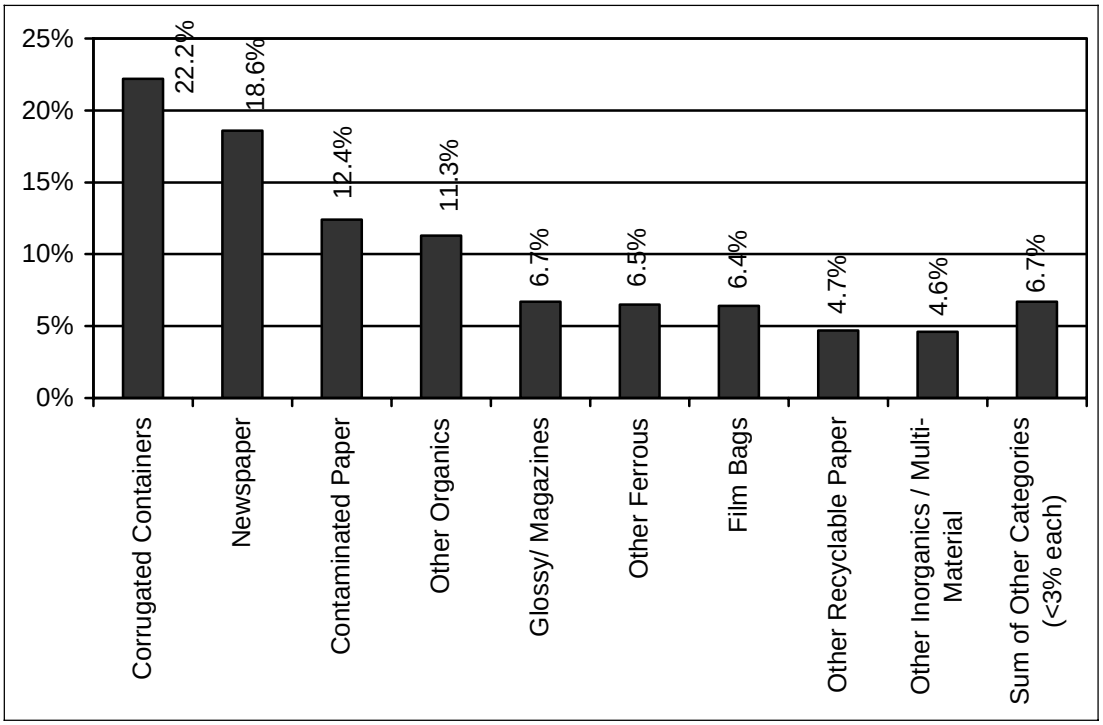
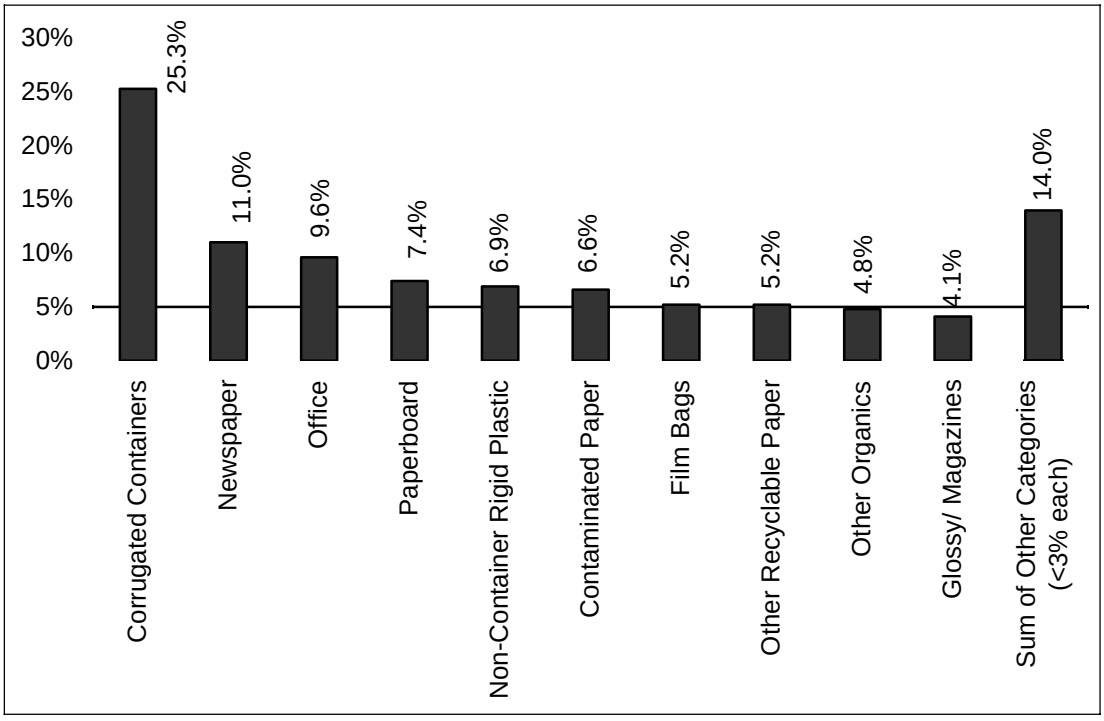


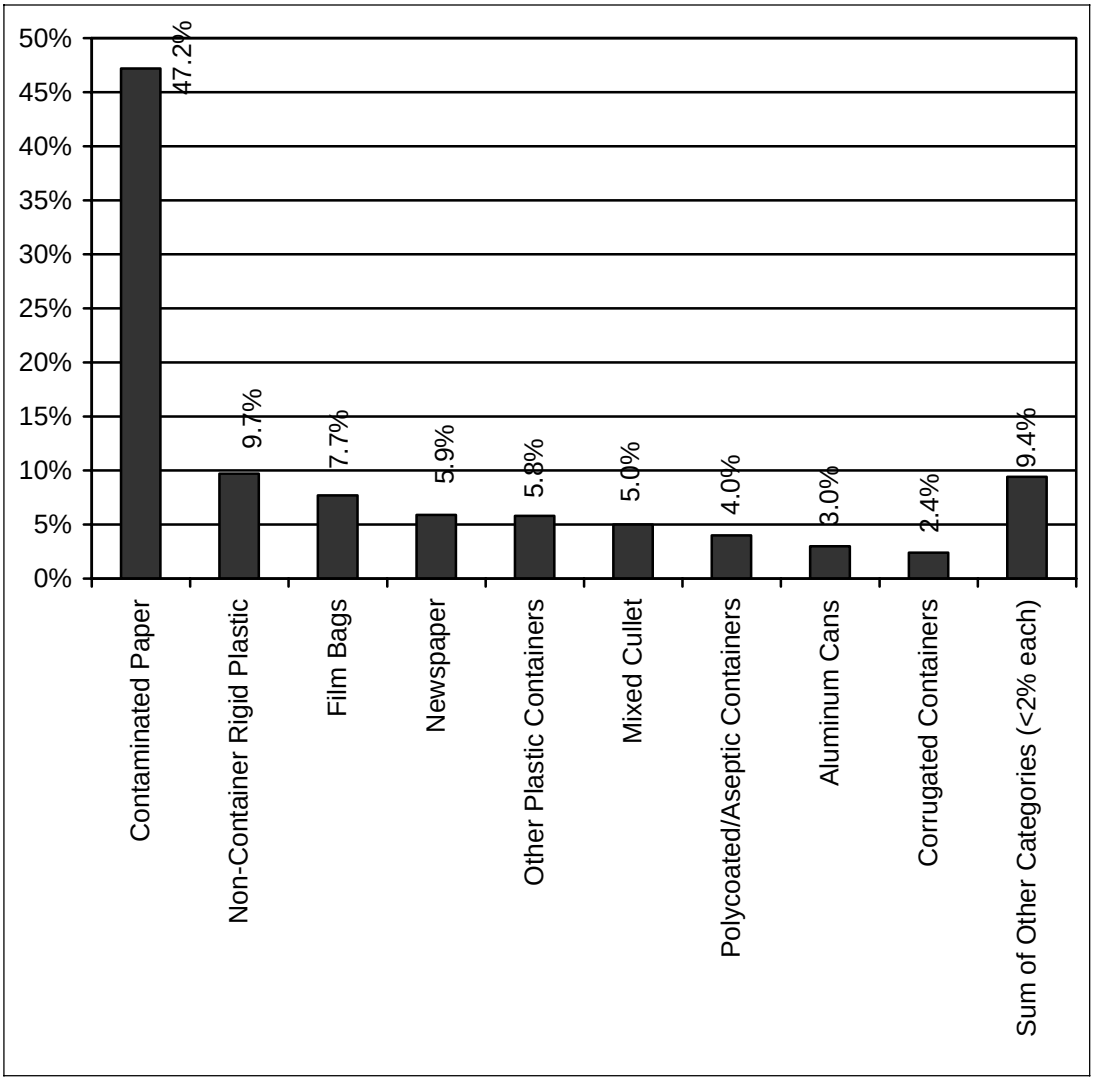
Figure A-11
Composition of Paper Sort Line Rejects



Note: composition based on data from two samples

Figure A-12 shows the composition of residue that falls off the end of the containers sort line.

Figure A-12
Composition of Containers Sort Line Residue



Note: composition based on data from two samples

Figure A-12 shows that the greatest component by far of the containers sort line residue is contaminated paper, with relatively low percentages being recyclable containers.

B.1 Collection and Processing Overview

The Centre County Solid Waste Authority (CCSWA) offers curbside and drop-off collection of residential recyclables throughout the county. Recyclables that are collected curbside are sorted at the truck into the following eight compartments:

- Newspaper (including office paper and junk mail, which are set out in a separate bag, and telephone directories);
- Magazines;
- Corrugated containers;
- PET and HDPE plastic bottles;
- Cans and aluminum foil;
- Clear glass containers;
- Brown glass containers; and
- Green and blue glass containers.

The CCSWA also operates over 100 drop-off locations with six-compartment collection containers. Materials accepted at the drop-offs are:

- Newspapers and telephone directories;
- PET and HDPE plastic bottles;
- Metal cans and aluminum foil;
- Clear glass containers;
- Brown glass containers; and
- Green glass containers.

In order to provide for processing of collected recyclables, CCSWA operates a materials recovery facility for the materials it collects as well as recyclables that are delivered by other public and private entities. Table B-1 shows the relative amounts of incoming materials by program source.

Table B-1
Centre Co. MRF Incoming Material Summary

Material Source	Annual Tons (CY01)	Percent of Total
Private Sector Commercial Collection Programs	2,308	22%
Local Curbside (Curb-Sort) Programs	3,688	35%
Penn State University Collection Program	1,453	14%
Local Drop-Off Programs	2,182	21%
Centre County Commercial Collection	783	8%
Total	10,414	100%

B.2 Sampling Summary

A four-day sampling and sorting event was conducted at the Centre County MRF from June 24 through June 27, 2002. The objective of the sampling event was to investigate the composition of materials as they are received and processed by the MRF. Three specific material streams were included in the sampling and sorting activities:

- Incoming materials from both residential and commercial generators;
- Processed (recovered) materials, such as mixed plastics and mixed paper; and
- Residues and contaminants that were ejected from various points along processing lines at the facility.

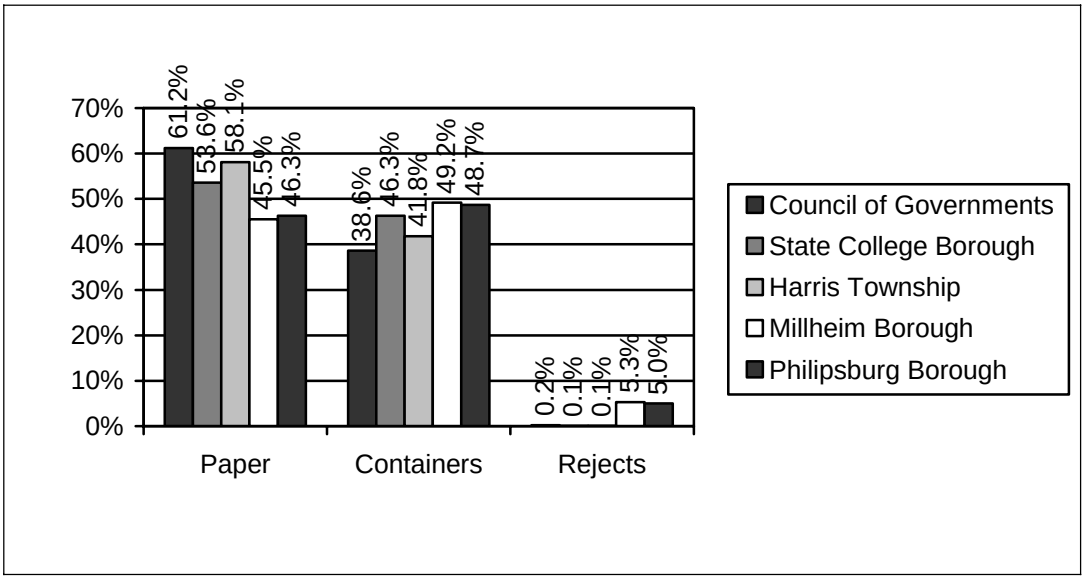
Material samples were taken from each of these three streams using a variety of techniques designed to assure that the samples would be representative. Because incoming material is received pre-sorted, samples generally encompassed sorting an entire incoming truckload by removing contaminants from each sorted fraction. Processed material samples were either taken from broken bales or from material storage containers in the MRF. Residues and contaminants were taken from appropriate ejection points in the facility.

Note that this study intended only to obtain a small number of representative samples from each of the material sources/streams described above. Because of the relatively limited number of samples, the results presented herein are not intended to individually reflect a statistically comprehensive picture of the material composition of targeted streams at this facility. However, this information is nonetheless useful for understanding the composition of material throughout the collection and processing of recyclable materials in the Commonwealth of Pennsylvania.

B.3 Composition of Incoming Materials

Figure B-1 compares the relative proportions of paper, containers, and rejects in incoming residential recyclables from various local sources. Material from the Centre Region Council of Governments[1], State College Borough, and Harris Township are collected curbside sort by regional refuse and recycling contracts and the rejects are extremely low. Material from Millheim Borough and Phillipsburg Borough are collected by drop-offs, with resulting higher levels of rejects.

Figure B-1
Composition of Incoming Residential Recyclables



Figures B-2 through B-6 show additional detail on the composition of incoming materials from the five program sources from which samples were taken. As the figures show, the curbside collection programs (which accept other paper in addition to newspapers) significantly increased the percentage of paper that is recovered compared to the drop-off programs.

[1] College, Ferguson, Harris and Patton Townships make up the Centre Region Council of Governments.

Figure B-2
Composition of Centre Region Council of Governments
Incoming Curb-Sort Materials

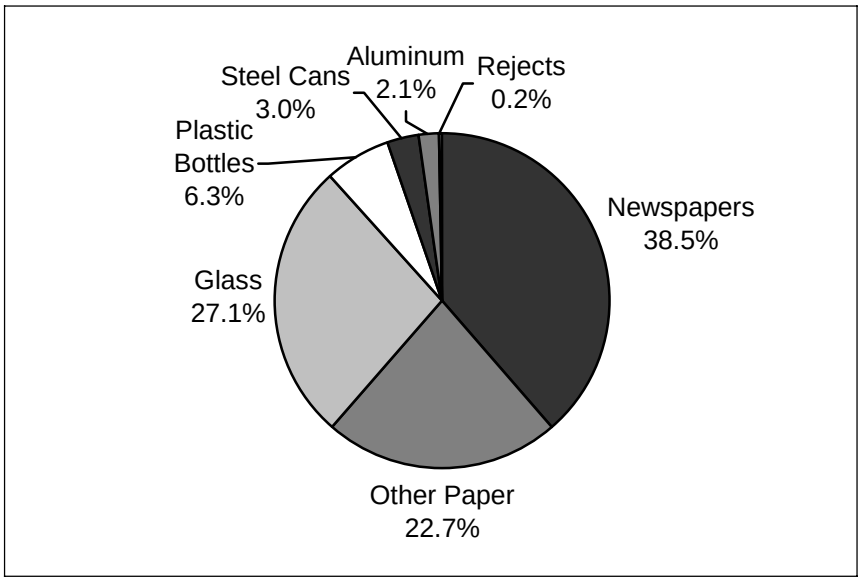


Figure B-3
Composition of State College Borough Incoming Curb-Sort Materials

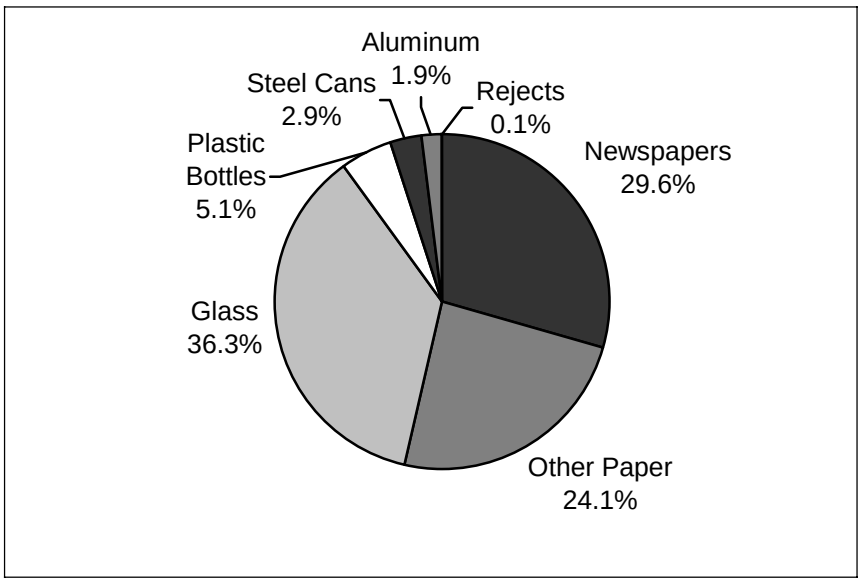


Figure B-4
Composition of Harris Township Incoming Curb-Sort Materials

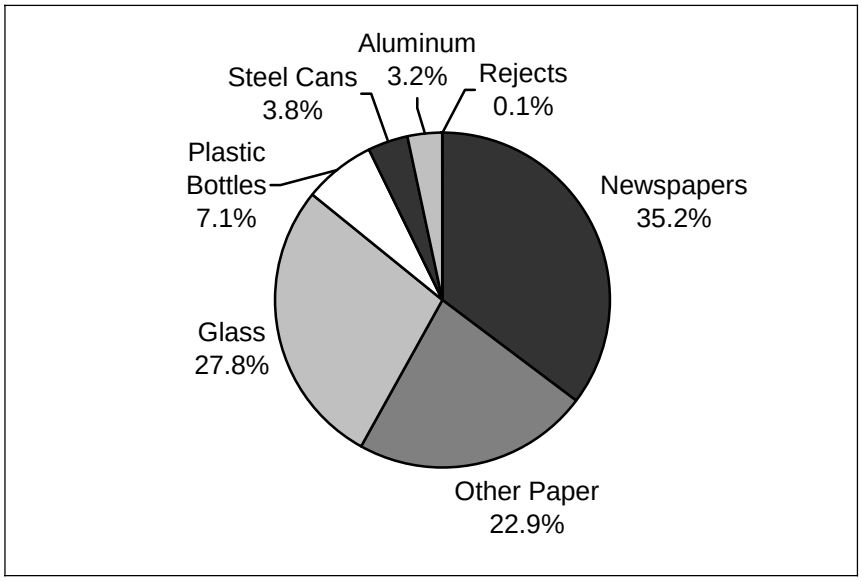


Figure B-5
Composition of Millheim Borough Incoming Drop-Off Materials

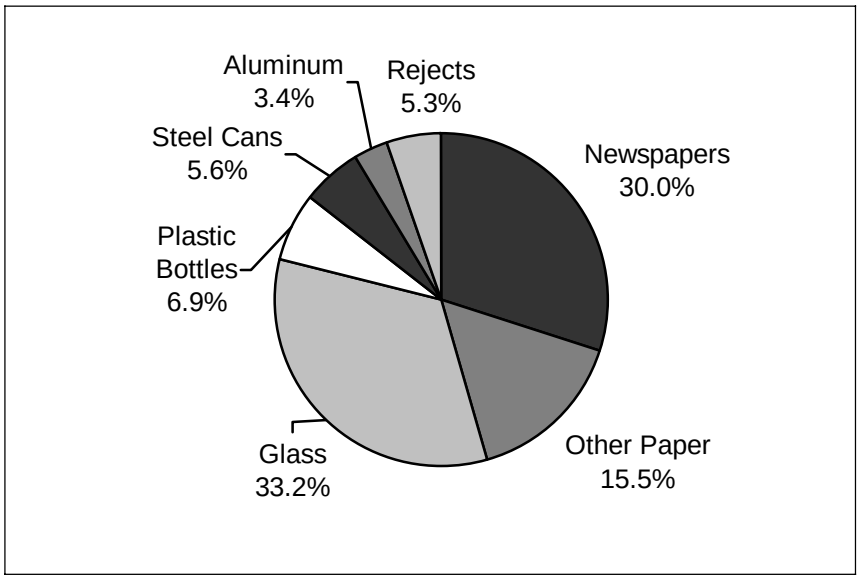


Figure B-6
Composition of Philipsburg Borough Incoming Drop-Off Materials

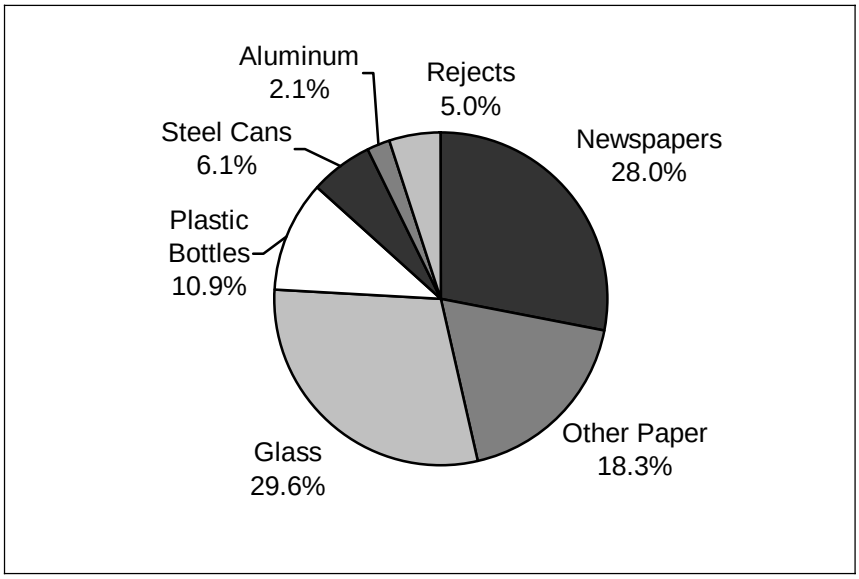


Figure B-7 shows the composition of incoming mixed commercial recyclables that contain both paper and containers from State College Borough. As the figure shows, glass containers make up half by weight of the materials recovered.

Figure B-7
Composition of State College Borough Incoming Commercial Materials

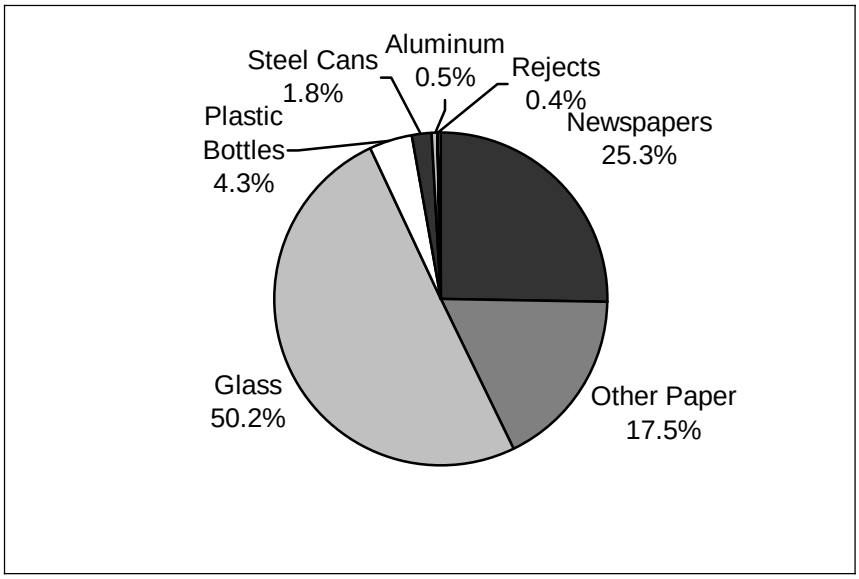
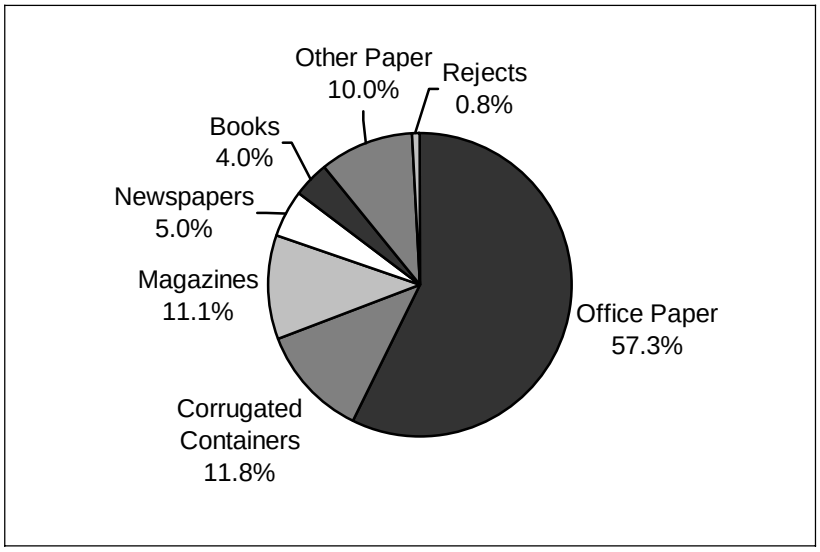


Figure B-8 shows the composition of incoming institutional mixed paper from Penn State University.

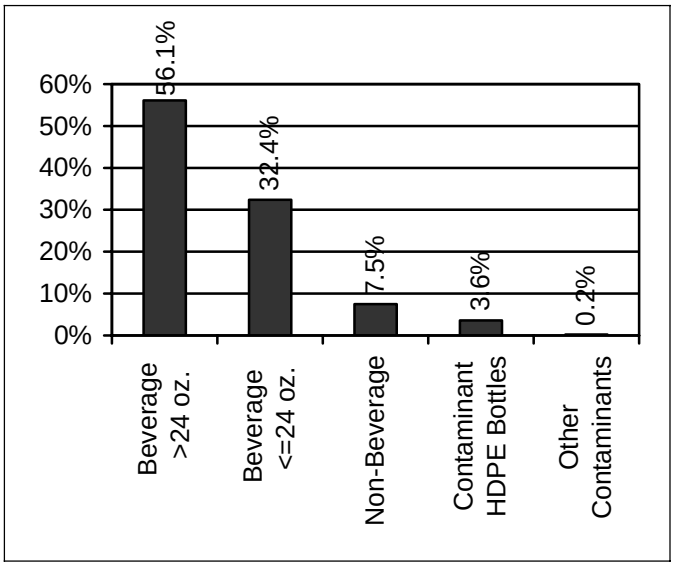
Figure B-8
Composition of Penn State University Incoming Mixed Paper



B.4 Composition of Processed Recyclables

Because most materials are received pre-sorted, little sorting is required at the MRF. Although markets for mixed plastic bottles exist, the MRF does sort plastic bottles by resin type. Natural and pigmented HDPE bottles are positively sorted and all contaminants are picked as well, leaving PET bottles as the negatively sorted fraction. Figures B-9, B-10, and B-11 show the composition of processed PET, natural HDPE, and pigmented HDPE bottles, respectively.

Figure B-9
Composition of Processed PET Bottles



The Other Contaminants shown in Figure B-9 are #3-#7 plastic bottles and rigid non-bottle plastics.

Figure B-10
Composition of Processed HDPE Natural Bottles

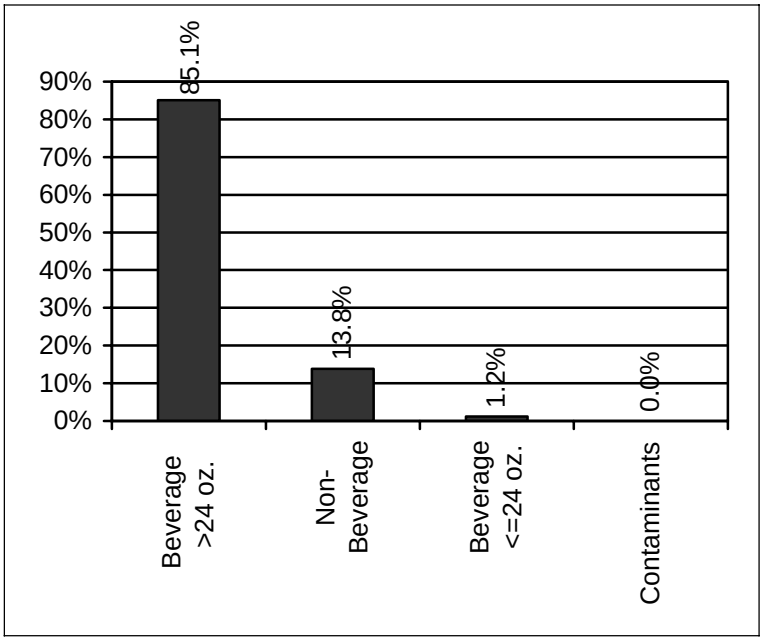
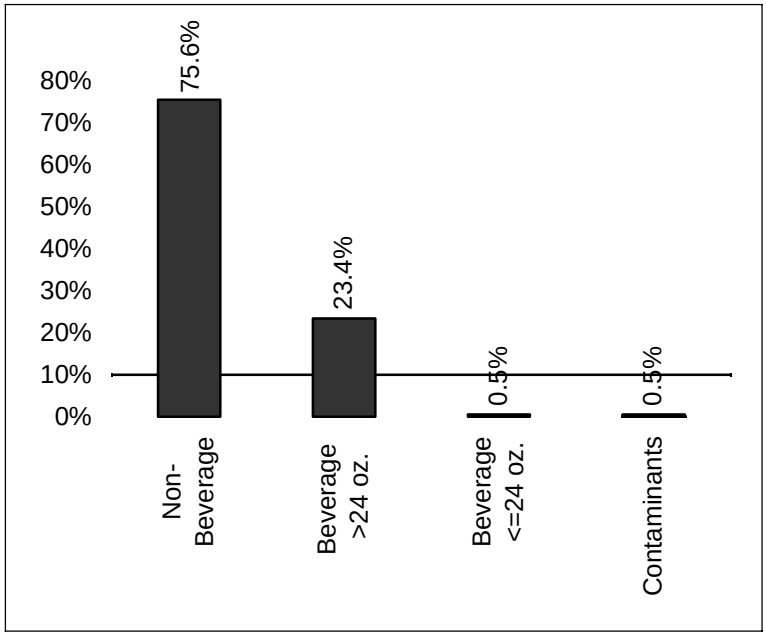


Figure B-11
Composition of Processed HDPE Pigmented Bottles



A large amount of pigmented milk jugs were found in the processed pigmented HDPE as shown in Figure B-11, resulting in a larger than normal percentage of >24 ounce

beverage bottles when compared to other locations in the Commonwealth. Contaminants shown in the figure are #3-#7 plastic bottles and rigid non-bottle plastics.

Figures B-12 and B-13 show the composition of processed newspaper and corrugated containers, respectively, that are marketed by CCSWA.

Figure B-12
Composition of Processed Newspaper

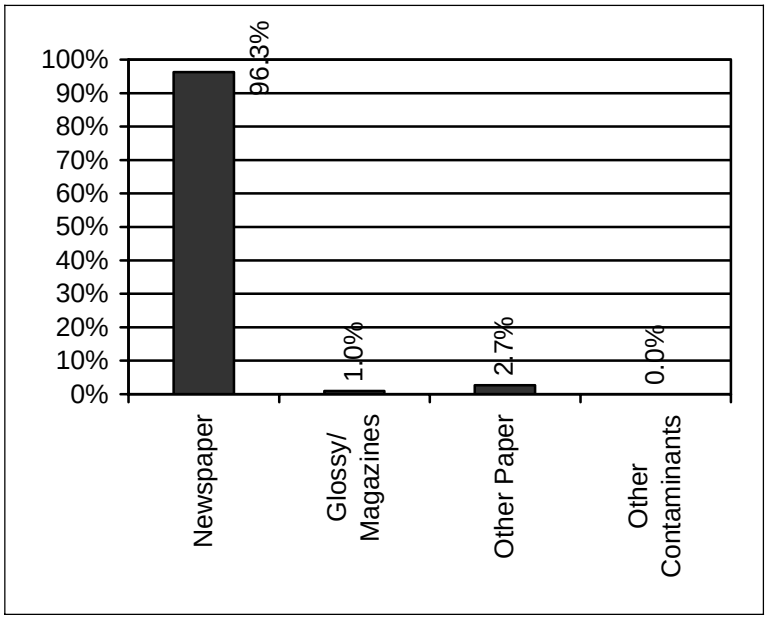
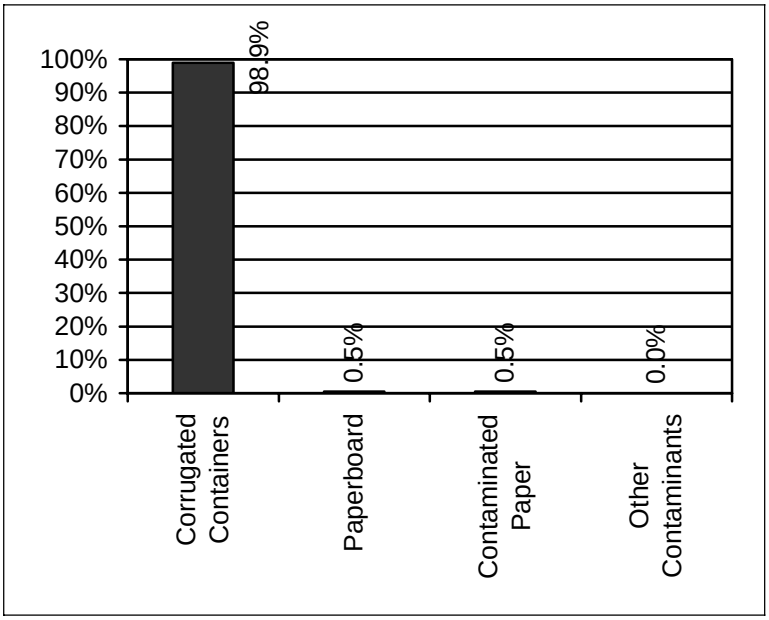


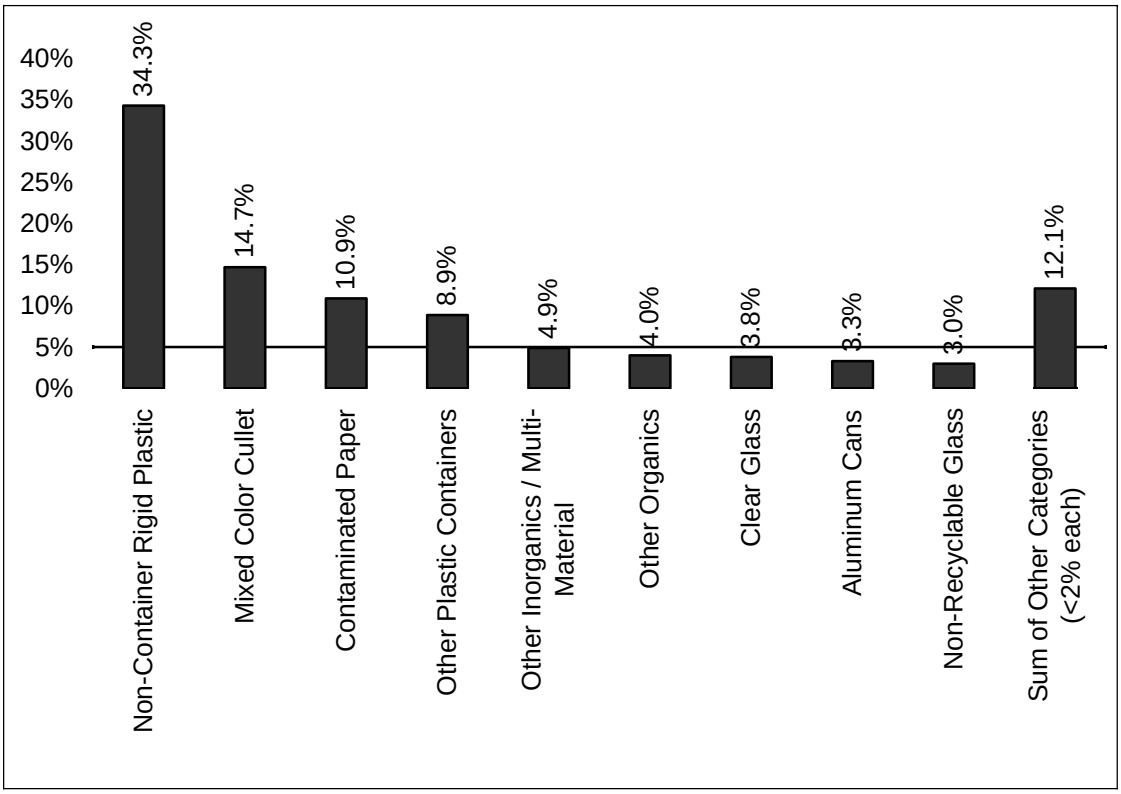
Figure B-13
Composition of Processed Corrugated Containers



B.5 Composition of Rejects and Residues

Materials to be baled are run over the sort line, which discharges to the baler. All rejects are therefore positively picked from the sort line, picked from piles of tipped materials, or swept off the floor. Figure B-14 shows the composition of facility rejects. Rejects were 2.2 percent of the facility throughput in calendar year 2001.

Figure B-14
Composition of Facility Rejects



C.1 Collection and Processing Overview

The Lackawanna County Recycling Center processes recyclables that are collected through a three-stream[2] curbside method by cities, townships, and boroughs that are located within the county and other surrounding counties such as Luzerne and Pike Counties. Residents and businesses are asked to recycle the following materials:

- Newspapers;
- Phone books;
- Magazines and catalogs;
- Office paper;
- Brown paper bags;
- Corrugated cardboard boxes;
- Aluminum cans;
- Aluminum foil;
- Steel cans;
- Glass bottles and jars; and
- All plastic bottles and jars

Table C-1 shows the sources of incoming materials received at the recycling center.[3]

Table C-1
Lackawanna Co. MRF Incoming Material Summary

Material Source	Annual Tons (CY01)	Percent of Total
On-Site Drop-Off Center [1]	NA	NA
Local Curbside, Drop-Off, and Commercial Three Stream Programs	15,109	94%
Corrugated Containers Collection (Commercial and Residential)	949	6%
Total	16,058	100%

1. The facility also accepts pallets and brush, which is not a material targeted in this study. The on-site drop-off materials are not weighed. Facility staff helps customers unload to guaranty quality.

[2] The three streams are: (1) commingled bottles and cans; (2) newspaper, magazines, phone directories, and office paper; and (3) brown bags and corrugated containers.
[3] These figures include the materials targeted for this study.

It should be noted that some municipalities collect containers one week and paper products the following week. Because of the short duration of recyclables sorts, information was not available for the overall composition of materials set out for recycling within individual municipalities.

C.2 Sampling Summary

A four-day sampling and sorting event was conducted at the Lackawanna County MRF on July 22 through July 25, 2002. The objective of the sampling event was to investigate the composition of materials as they are received and processed by the MRF. Three specific material streams were included in the sampling and sorting activities:

- Incoming materials from both residential and commercial generators;
- Processed (recovered) materials, such as mixed plastics and mixed paper; and
- Residues and contaminants that were ejected from various points along processing lines at the facility.

Material samples were taken from each of these three streams using a variety of techniques designed to assure that the samples would be representative. Incoming material samples of containers generally included sorting the entire load to assure that no bias was introduced in the sample. Alternatively, samples were taken from incoming paper as separation of materials was not anticipated during transportation. Processed material samples were either taken from broken bales, from the end of conveyor belts, or from material storage containers in the MRF. Residues and contaminants were taken similarly from appropriate ejection points in the facility.

Note that this study intended only to obtain a small number of representative samples from each of the material streams described above. Because of the relatively limited number of samples, the results presented herein are not intended to individually reflect a statistically comprehensive picture of the material composition of targeted streams at this facility. However, this information is nonetheless useful for understanding the composition of material throughout the collection and processing of recyclable materials in the Commonwealth of Pennsylvania.

C.3 Composition of Incoming Materials

Figures C-1 through C-5 show the composition of incoming curbside-collected commingled containers from five municipalities. As the figures show, glass containers make up the largest component of the containers that are collected, ranging from 45-76 percent of the load by weight.

Figure C-1
Composition of Dickson City Borough
Incoming Curbside Commingled Containers

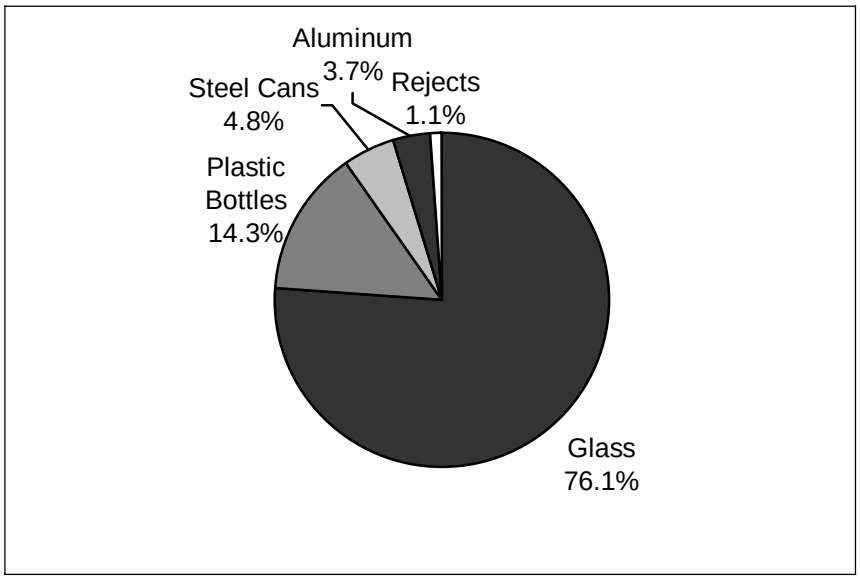


Figure C-2
Composition of City of Scranton
Incoming Curbside Commingled Containers

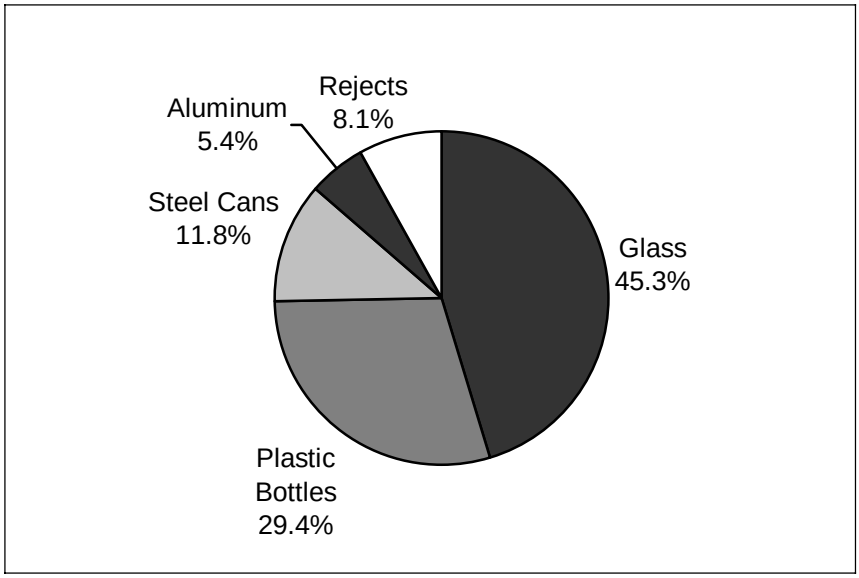


Figure C-3
Composition of Olyphant Borough
Incoming Curbside Commingled Containers

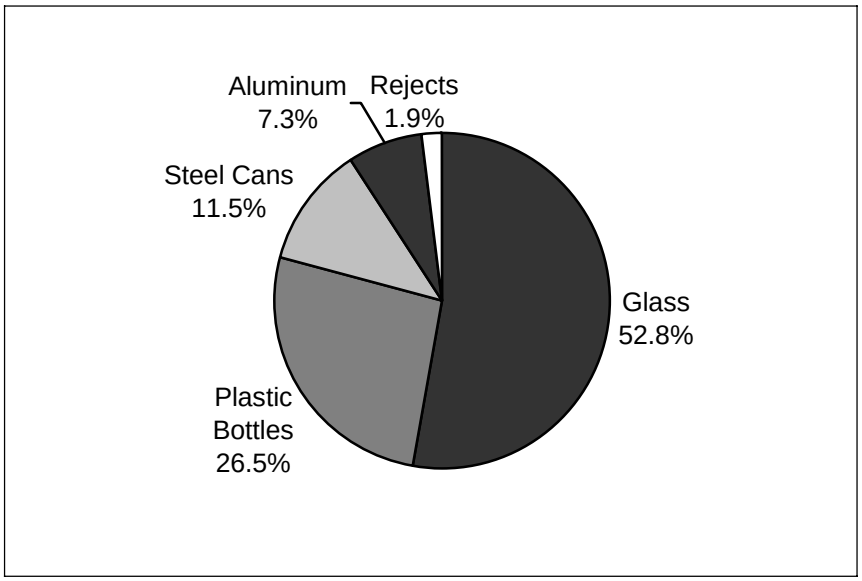


Figure C-4
Composition of Dunmore Borough
Incoming Curbside Commingled Containers

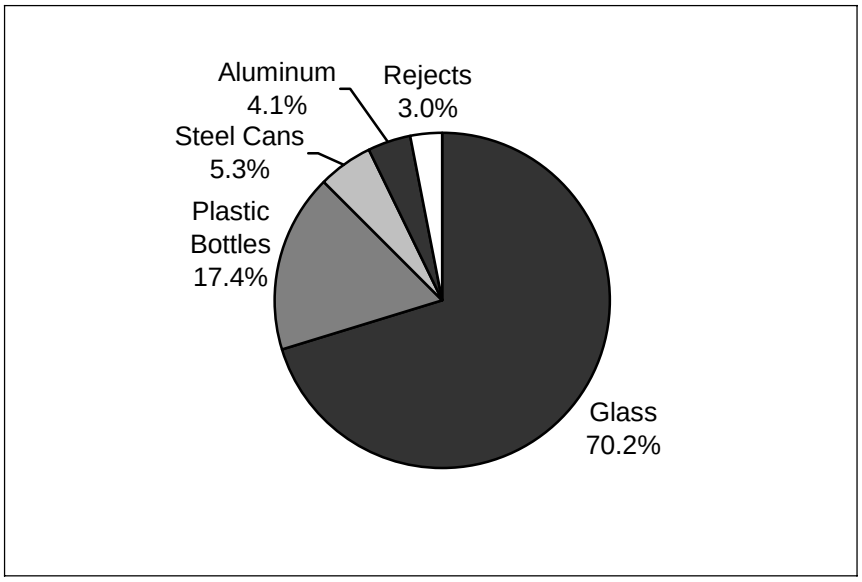


Figure C-5
Composition of Jermyn Borough
Incoming Curbside Commingled Containers

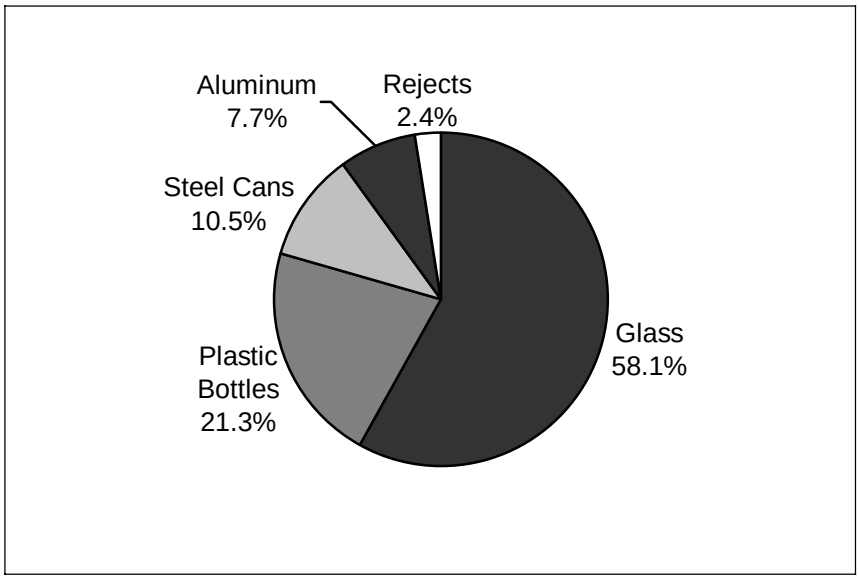
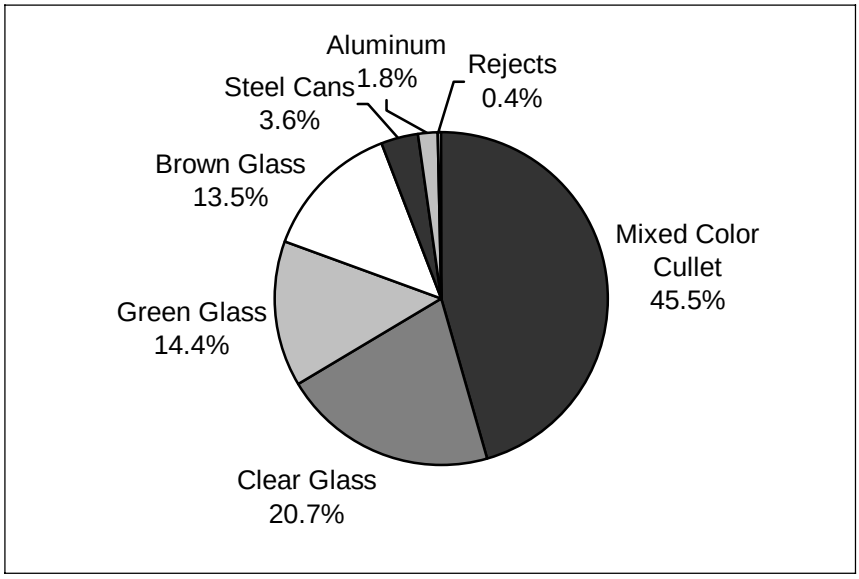


Figure C-6 shows the composition of incoming drop-off glass and cans from Pike County. Plastic bottles and paper are collected in separate drop-off containers that were not able to be sampled in this study.

Figure C-6
Composition of Pike County Incoming Drop-Off Glass and Cans



Figures C-7 and C-8 show the composition of incoming curbside paper to the MRF from two separate municipalities. In both cases, newspaper comprised approximately 75 percent of the incoming load.

Figure C-7
Composition of Archbald Borough Incoming Curbside Paper

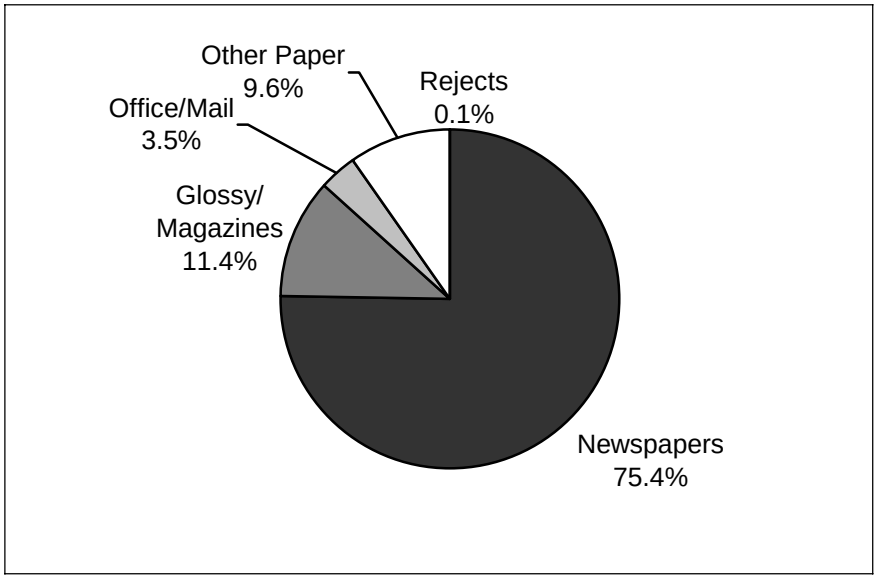
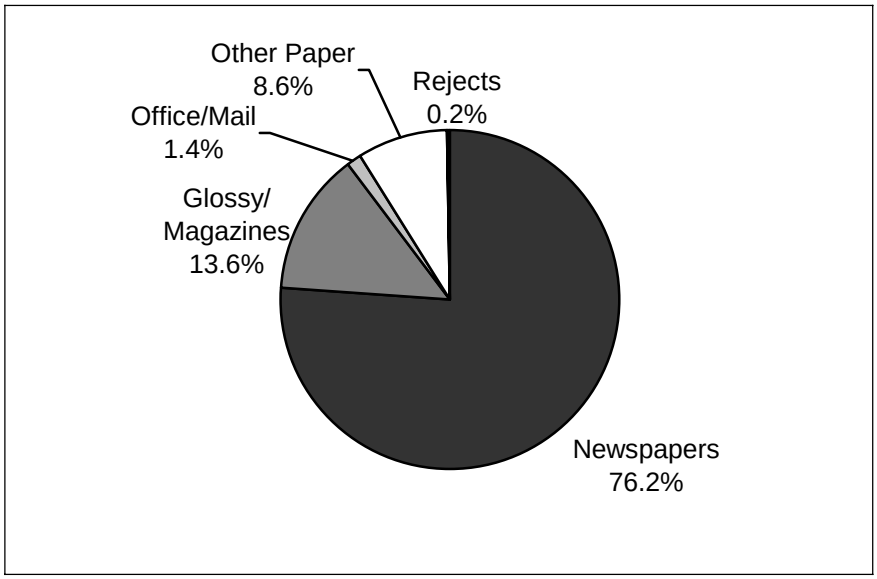


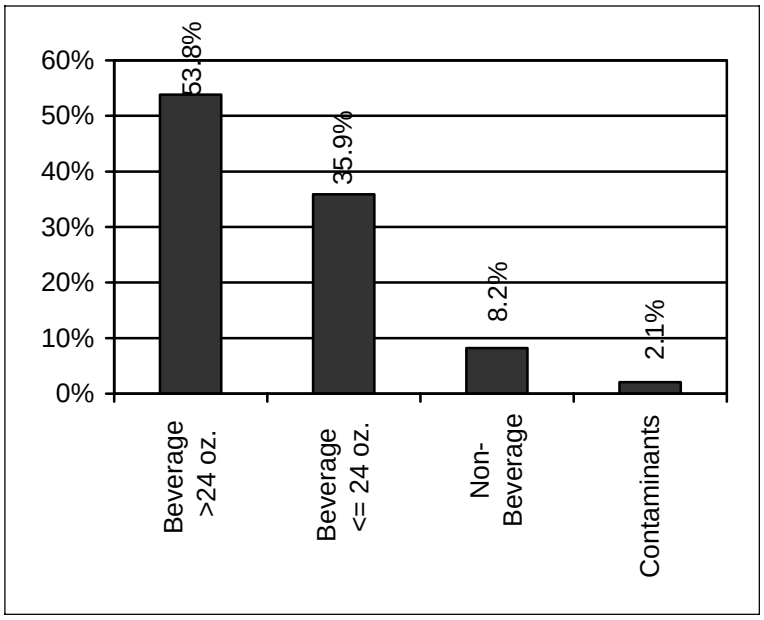
Figure C-8
Composition of Moosic Borough Incoming Curbside Paper



C.4 Composition of Processed Recyclables

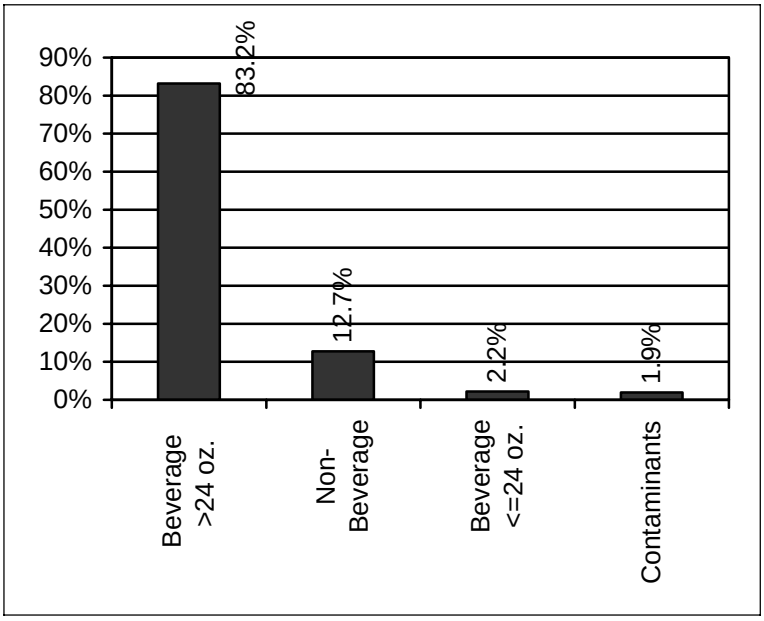
Figures C-9 through C-11 show the composition of processed PET and HDPE plastic bottles.

Figure C-9
Composition of Processed PET Bottles



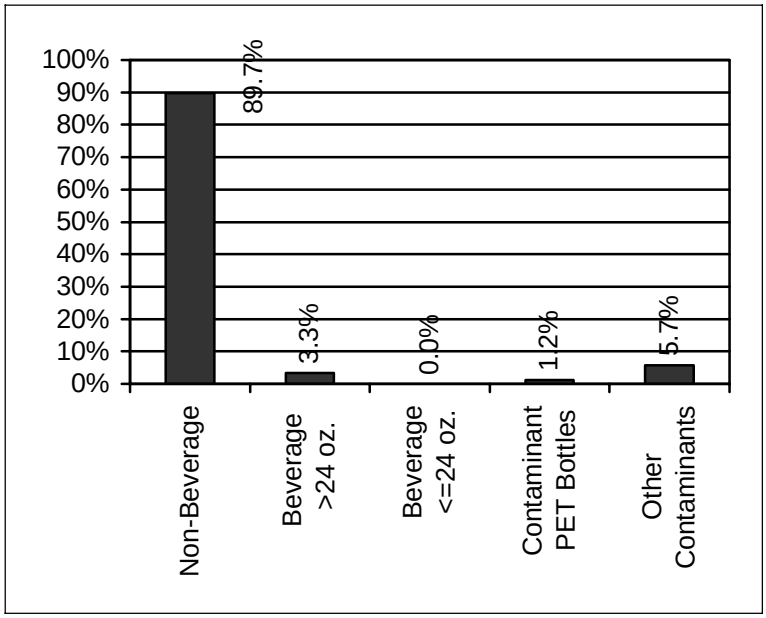
The contaminants shown in Figure C-9 are primarily non-bottle plastic containers, #3-#7 plastic bottles, rigid non-container plastics, and aluminum cans.

Figure C-10
Composition of Processed HDPE Natural Bottles



The contaminants shown in Figure C-10 are primarily non-bottle plastic containers and rigid non-container plastics.

Figure C-11
Composition of Processed HDPE Pigmented Bottles



The contaminants shown in Figure C-11 are primarily non-bottle plastic containers, #3-#7 plastic bottles, and rigid non-bottle plastics.

Figures C-12 and C-13 show the composition of processed newspaper and corrugated containers, respectively.

Figure C-12
Composition of Processed Newspaper

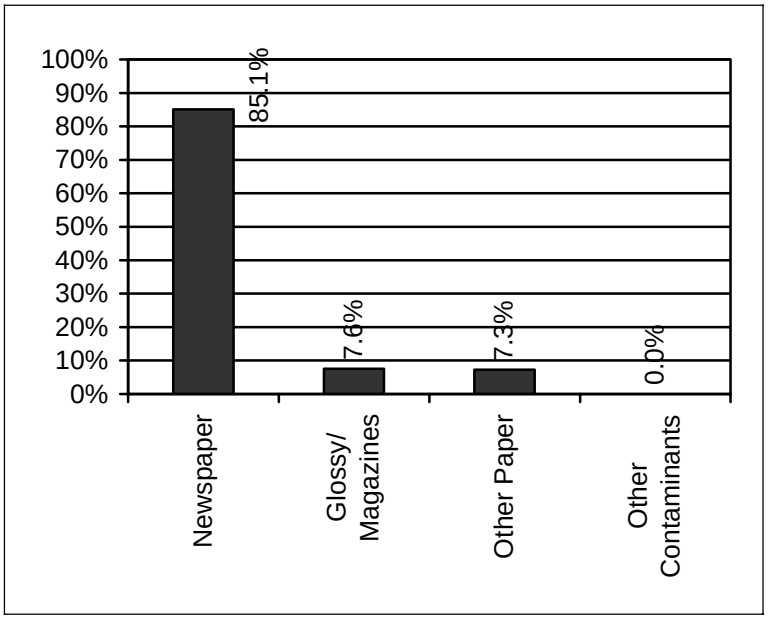
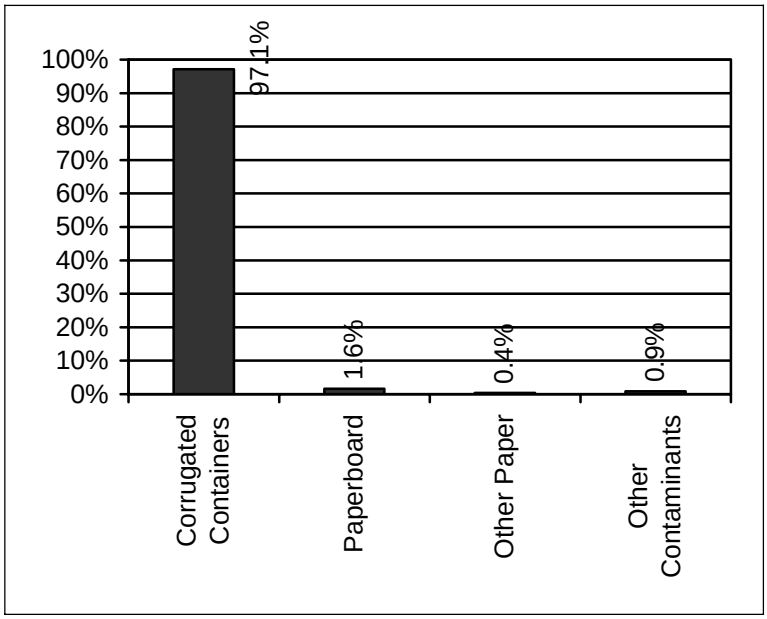


Figure C-13
Composition of Processed Corrugated Containers

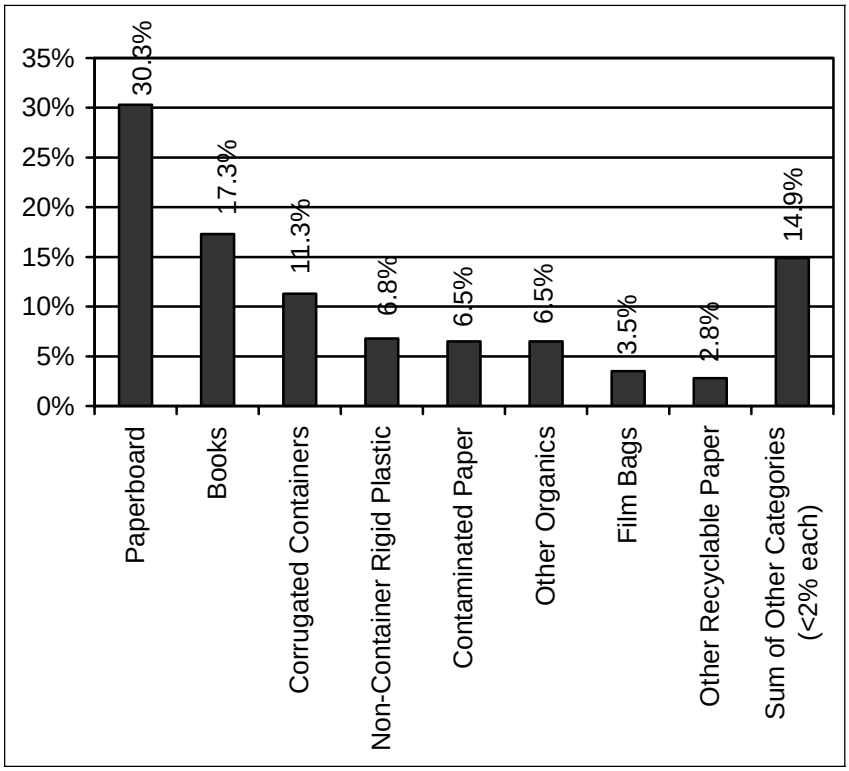


The Other Contaminants shown in Figure C-13 are primarily film bags.

C.5 Composition of Rejects and Residues

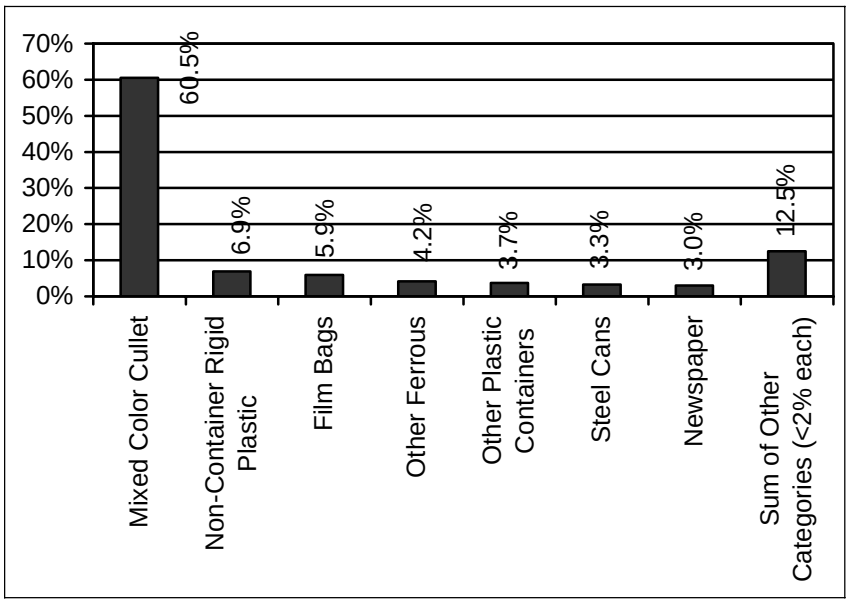
The recycling center has three sorting lines, one for newspaper, one for corrugated containers, and the third for commingled containers. Contaminants are picked from the paper streams and the paper that remains on the belts goes directly to balers. Figure C-14 shows the composition of rejects from the residential newspaper line.

Figure C-14
Composition of Residential Paper Sort Line Rejects



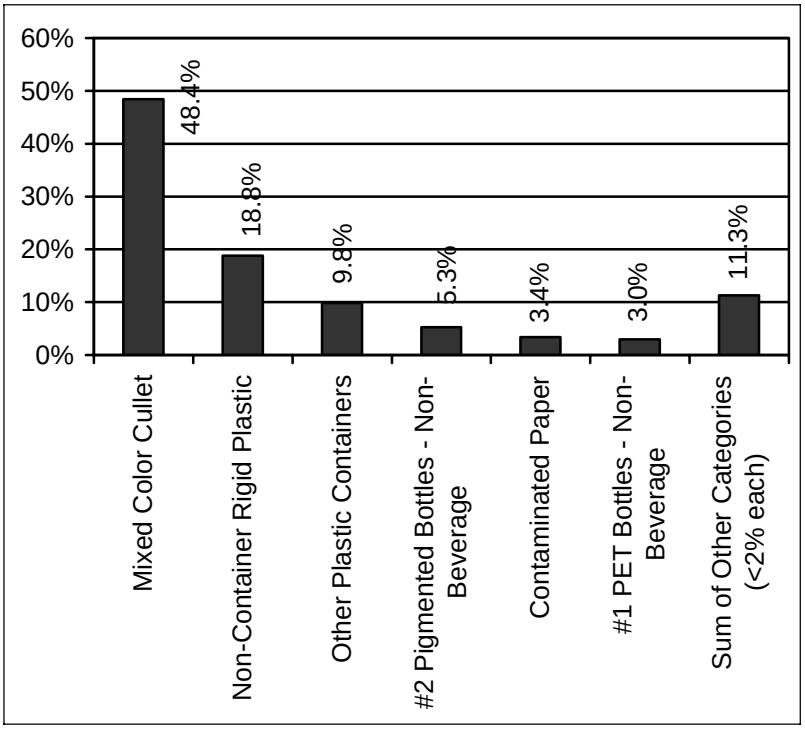
The containers sort line begins with an overhead magnet to remove ferrous materials. The remaining materials then pass through a trommel where small residues fall out. Figure C-15 shows the composition of residues that are removed at the trommel.

Figure C-15
Composition of Containers Sort Line Residues



After the trommel an air classifier separates light materials (plastics and aluminum) from glass for additional sorting. Figure C-16 shows the composition of residue that falls off the end of the lights processing line.

Figure C-16
Composition of Light Containers Sort Line Residue



Appendix D
LYCOMING COUNTY RECYCLING CENTER

D.1 Collection and Processing Overview

The Lycoming County Recycling Center processes residential source separated recyclables, commercial OCC, and mixed office paper recyclables from a range of sources. Table D-1 provides a detailed accounting of the materials processed by the facility.

Table D-1
Incoming Material Summary

Generating Sector	Material Type	Total Incoming Annual Tons	Percentage Composition
Curbside	Clear Glass	117.68	1%
Drop-off	Clear Glass	595.05	7%
Commercial	Clear Glass	98.38	1%
Processed	Clear Glass	105.50	1%
Curbside	Brown Glass	30.78	<1%
Drop-off	Brown Glass	22.07	<1%
Commercial	Brown Glass	185.61	2%
Processed	Brown Glass	68.07	1%
Curbside	Green Glass	24.78	<1%
Drop-off	Green Glass	17.58	<1%
Commercial	Green Glass	55.70	1%
Processed	Green Glass	57.22	1%
Curbside	Steel/Tin Cans	83.03	1%
Drop-off	Steel/Tin Cans	325.44	4%
Commercial	Steel/Tin Cans	63.95	1%
Curbside	Aluminum Cans	23.87	<1%
Drop-off	Aluminum Cans	123.01	1%
Commercial	Aluminum Cans	9.30	<1%
Curbside	HDPE/PET	9.57	<1%
Drop-off	HDPE/PET	640.14	8%
Commercial	HDPE/PET	75.53	1%
Drop-off	PET	8.95	<1%
Commercial	PET	7.51	<1%
Drop-off	HDPE	10.13	<1%
Commercial	HDPE	9.04	<1%
Drop-off	ONP	121.39	1%
Commercial	ONP	164.38	2%
Industrial	Industrial Loose Magazines	16.47	<1%
Drop-off	Magazines	105.19	1%
Commercial	Magazines	258.8	3%
Drop-off	ONP/Magazines	420.53	5%

Generating Sector	Material Type	Total Incoming Annual Tons	Percentage Composition
Commercial	ONP/Magazines	9.68	<1%
Industrial	Industrial Loose OCC	301.98	4%
Drop-off	OCC	1,269.20	15%
Commercial	OCC	2,476.96	30%
Processed	OCC	73.91	1%
Commercial	Office Paper	82.45	1%
Commercial	Industrial Loose Mixed Office	25.46	<1%
Drop-off	Mixed Office	2.36	<1%
Industrial	Incoming Packaging Weight	49.24	1%
Industrial	Industrial 3-Mil Plastic Film	2.01	<1%
Industrial	Industrial Mixed PVC	198.75	2%
Grand Total		8,346.65	100%

The majority of the recyclable materials delivered to the facility are generated from the Lycoming County Resource Management Services recycling program. The County currently collects roll-off containers from drop-off recycling locations across the County. Other nearby Counties also deliver curbside and drop-off recyclables. The facility also accepts commercial mixed office paper and OCC from private sector recyclers. Some 63 percent of material processed comes from drop-off programs with most of the rest of the material coming from commercial recycling programs. Approximately 4 percent of incoming materials are received in processed form from commercial businesses in Lycoming or surrounding counties. These materials consist of glass and corrugated containers. Only 2 percent comes from curbside collection of residential recyclables.

Incoming material is received and processed as described below.

- **Tip Floors:** All incoming source separated material is tipped on one of two tip floors. The main tip area has 9 bunkers to accommodate the mixed plastic bottles, aluminum cans, steel cans, glass, ONP, magazines, and mixed office paper. Each stream is dumped and pushed into the appropriate bunker. OCC is dumped on a separate tip floor located on the opposite side of the building.
- **Manual Sort Line:** Because most materials arrive separated, the primary function of sorting is to separate out residue (trash). Materials are therefore batch processed – one type of material at a time. Newspapers, office paper, and all containers are processed on an elevated manual sorting line. Nearly all materials that enter the sort line are negatively sorted, meaning that contaminants are removed from the sorting conveyor belt. An exception is plastic bottles, which are positively sorted, meaning that they are removed from the sorting conveyor belt and deposited into an appropriate bunker. All sorted materials are deposited into separate processed material bunkers for future baling, except for the glass, which is transported to one of the three outside storage bunkers for each of the colors of glass.
- **OCC Sorting Area:** Incoming OCC is dumped on an OCC tip floor and manually sorted on the floor. All contaminants are removed and are loaded into

roto-hoppers that are dumped in a trash bunker for disposal. The clean OCC that remains on the floor is loaded into the horizontal baler using a bobcat loader.

- **Baling/Densifying:** The facility two horizontal balers. One is used for OCC and the other for plastics, steel cans, and all other paper. Aluminum cans are densified into biscuits.

Details for the manual sort line process are provided below.

- Individual recyclable materials are loaded from their incoming storage bunkers onto a feed convey and transported to the elevated sorting platform;
- Except for plastics, all materials are negatively sorted and contaminants that are "picked off" the line are deposited down chutes to a trash takeaway conveyor that conveys the material to an outdoor bunker. When plastics are processed, however, residue is negatively sorted and travels to the end of the sort line where it too is conveyed to the outdoor bunker;
- Mixed plastic bottles are separated into PET, natural HDPE, and pigmented HDPE grades. Each plastic resin type is positively sorted and deposited in a flattener above its individual cage;

Table D-2 summarizes the materials recovered and marketed by the facility.

Table D-2
Recovered Materials

Material Type	Annual Outgoing Tons	Percentage of Tons
Fiber		
ONP	2,906.7	24%
Magazines	1,346.9	11%
OCC	3,679.1	31%
Mixed Office	102.7	1%
Subtotal	*8,035.4*	*67%*
Containers		
Packaging Weight	8.9	0%
Clear Glass	778.6	6%
Brown Glass	466.2	4%
Green Glass	335.9	3%
Steel/Tin Cans	410.2	3%
Aluminum Cans	110.4	1%
PETE	251.1	2%
HDPE Nat	112.6	1%
HDPE Colored	115.6	1%
Mixed PVC	187.1	2%
Subtotal	*2,776.6*	*23%*
Contaminants/Residues	1,180.2	10%
Grand Total	**11,992.2**	100%

Note: based on average monthly data from November 2003 - January 2004

D.2 Sampling Summary

A four-day sampling and sorting event was conducted at the Lycoming County Recycling Center from April 13-16, 2004. The objective of the sampling event was to investigate the composition of materials as they are received and processed by the Recycling Center. Three specific material streams were included in the sampling and sorting activities:

- Incoming materials from both residential and commercial generators;
- Processed (recovered) materials, such as mixed plastics and newspaper; and
- Residues and contaminants that were ejected from various processing points at the facility.

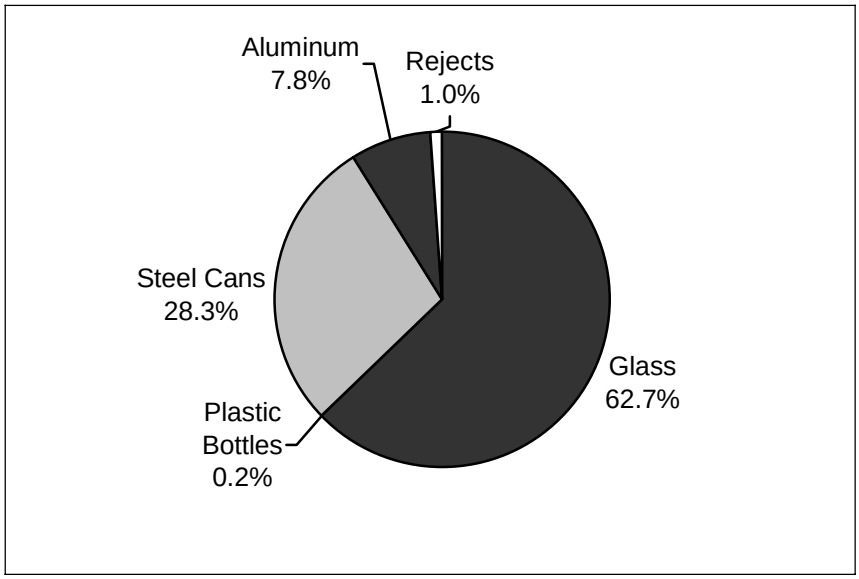
Material samples were taken from each of these three streams using techniques designed to assure that the samples would be representative. Incoming material samples from drop-offs included a representative "scoop" of material, while whole loads were sorted from incoming curbside-sort material. Processed material samples were either taken from broken bales, from the end of conveyor belts, or from material storage containers in the MRF. Residues and contaminants were taken similarly from appropriate ejection points in the facility. Sample sizes were targeted for 250 to 300 pounds.

This study intended to obtain samples primarily from incoming materials, with several samples reserved for processed materials and rejects and residues. This sampling plan was selected to provide the best statistical confidence on composition data from incoming material.

D.3 Composition of Incoming Materials

Williamsport only accepts steel cans, aluminum cans, and glass containers in its curbside sort collection program. The composition of Williamsport's curbside material is shown in Figure D-1.

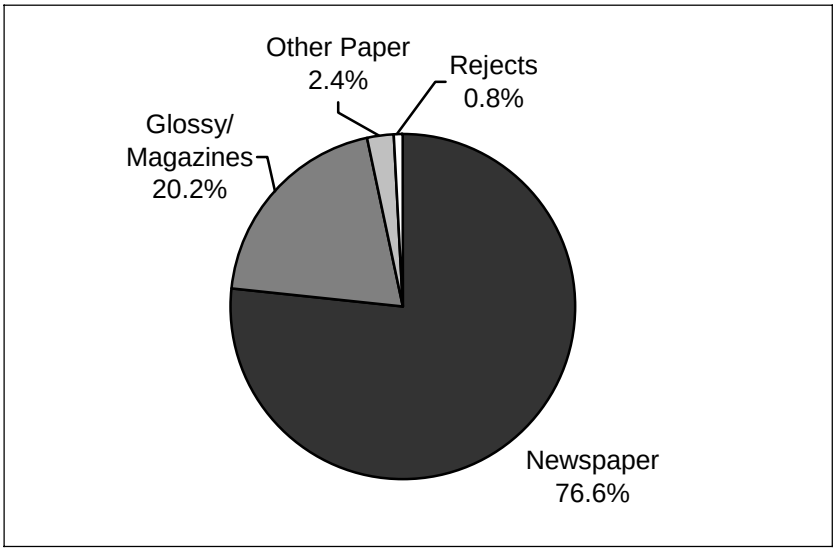
Figure D-1
Composition of Williamsport Incoming Curbside Sort Containers



Note: composition based on data from two incoming loads

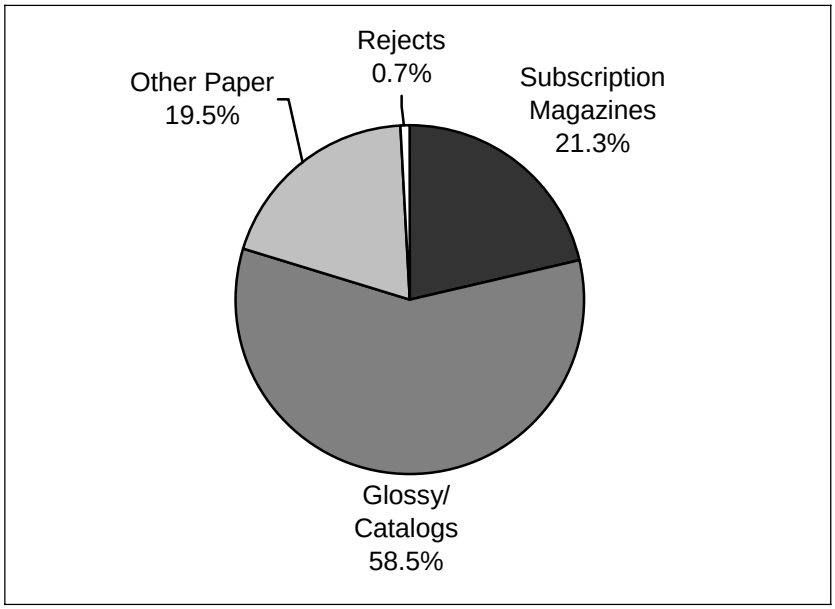
Figures D-2 and D-3 show the composition of incoming drop-off newspaper and magazines. It should be noted that non-paper rejects were found to be minimal in the incoming paper drop-off material.

Figure D-2
Composition of Incoming Drop-Off Newspaper



Note: composition based on sample data from three separate incoming loads

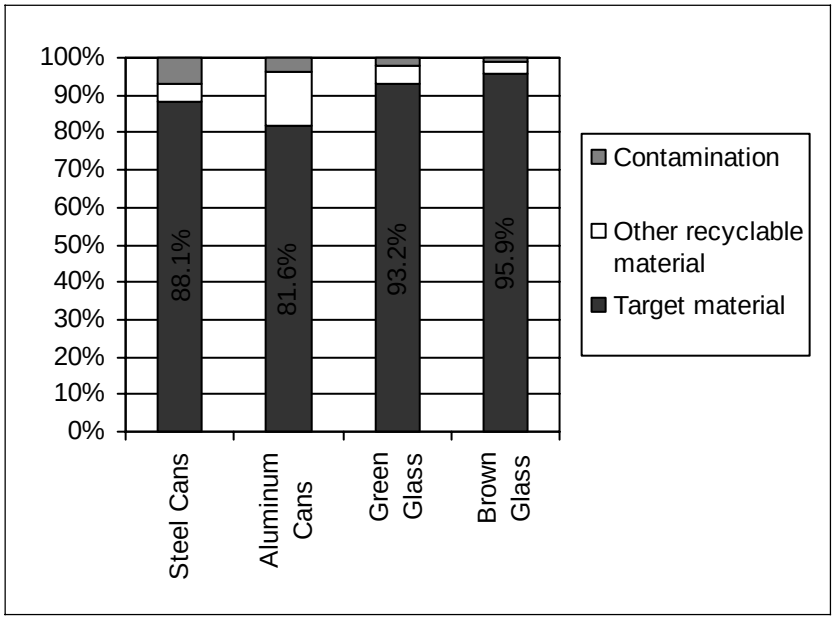
Figure D-3
Composition of Incoming Drop-Off Magazines



Note: composition based on sample data from three separate incoming loads

Figure D-4 shows the composition of mono-streams of incoming drop-off cans and glass. As the figure shows, contamination of those materials, particularly aluminum cans, is problematic.

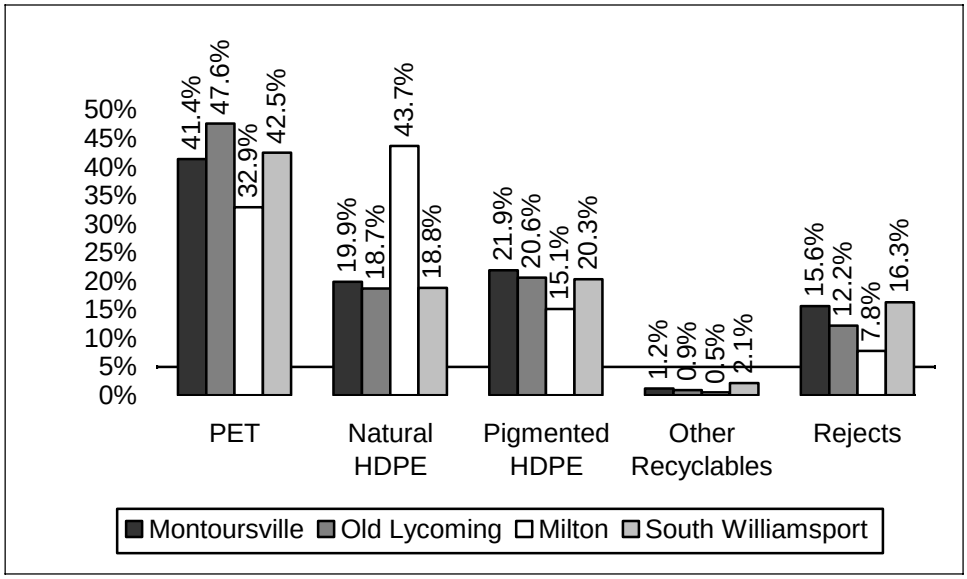
Figure D-4
Composition of Incoming Drop-Off Containers



Note: composition based on two steel can samples and one sample each from the remaining materials

Figure D-5 shows the composition of incoming drop-off plastic bottles. Rejects were significant and a majority of the rejects were non-bottle plastics.

Figure D-5
Composition of Incoming Drop-Off Plastic Bottles



Figures D-6, D-7, and D-8 show the composition of incoming commercial recyclables. As the figures show, non-conforming materials were minor in incoming office paper from Williamsport; alternatively, nonconforming materials were significant in the incoming office paper from Union County and incoming OCC.

Figure D-6
Composition of Incoming Union County Office Paper

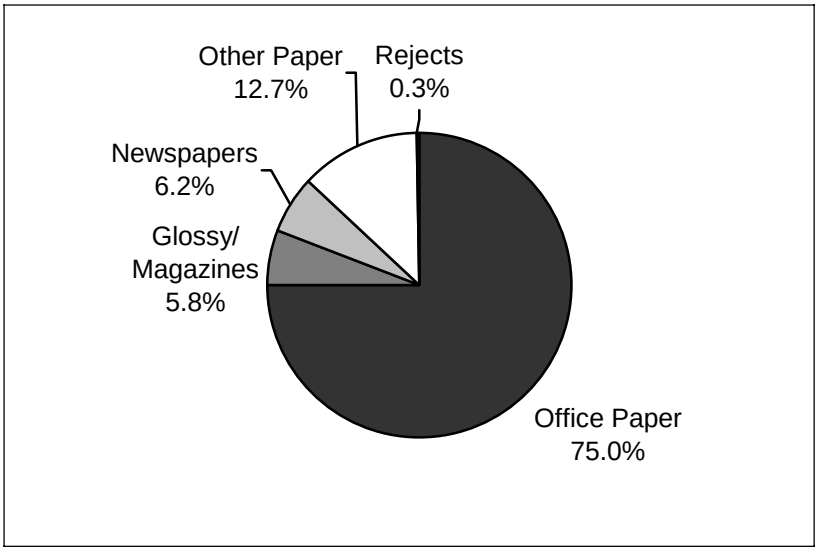


Figure D-7
Composition of Incoming Williamsport Office Paper

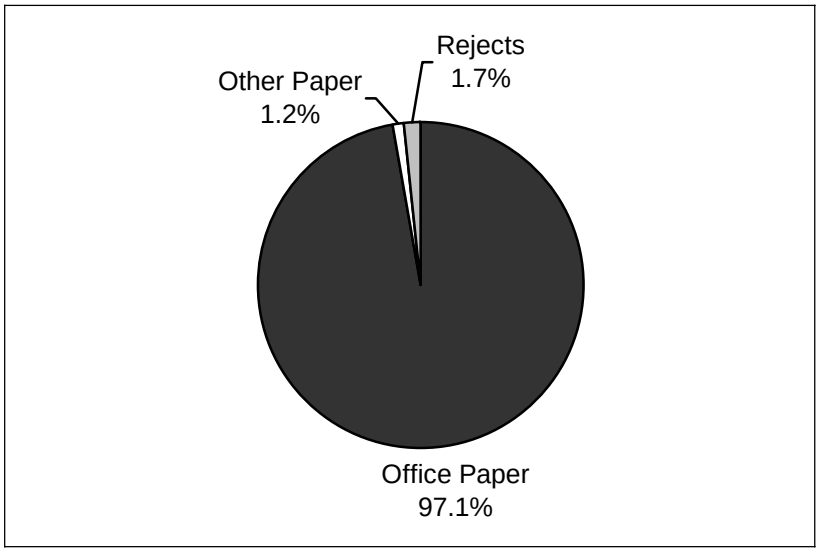
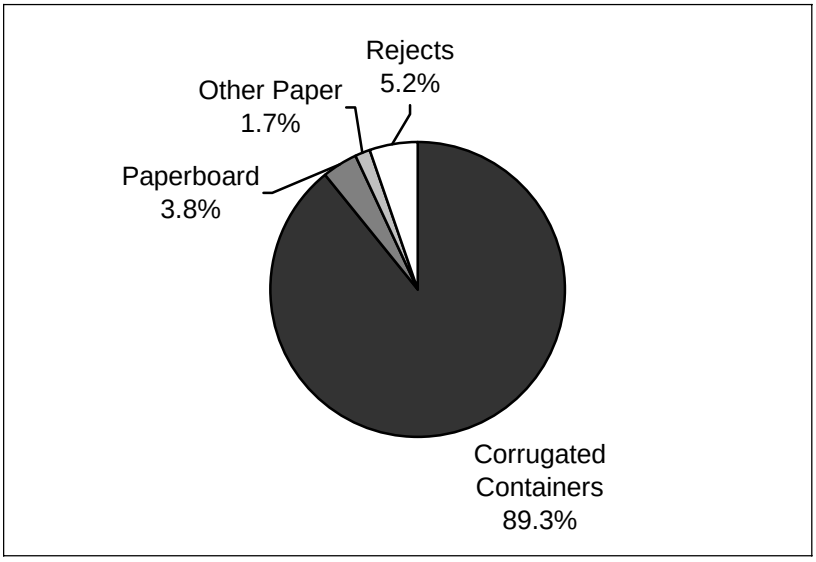


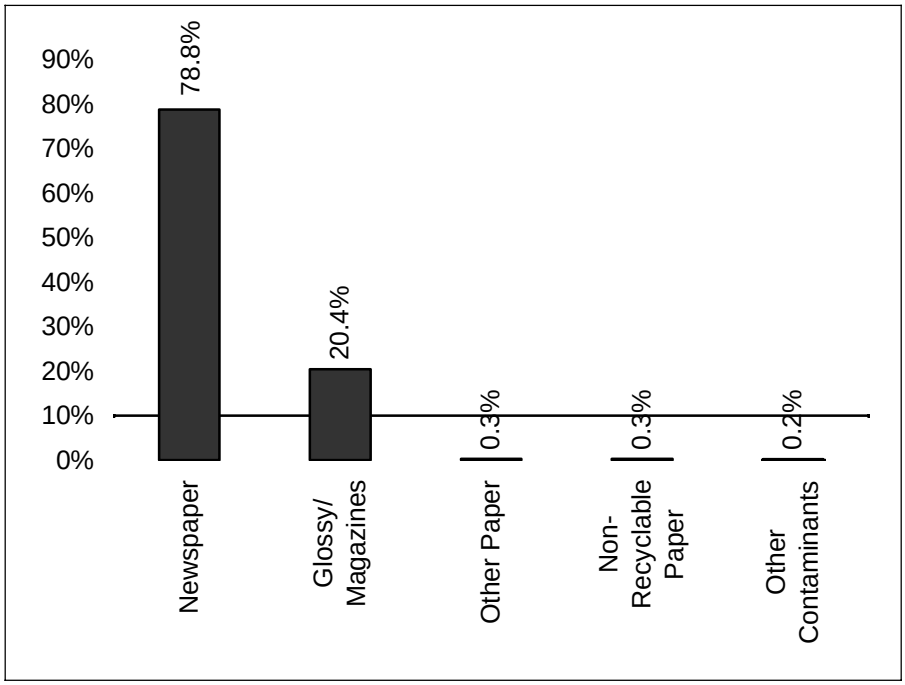
Figure D-8
Composition of Incoming Williamsport Corrugated Containers



D.4 Composition of Processed Recyclables

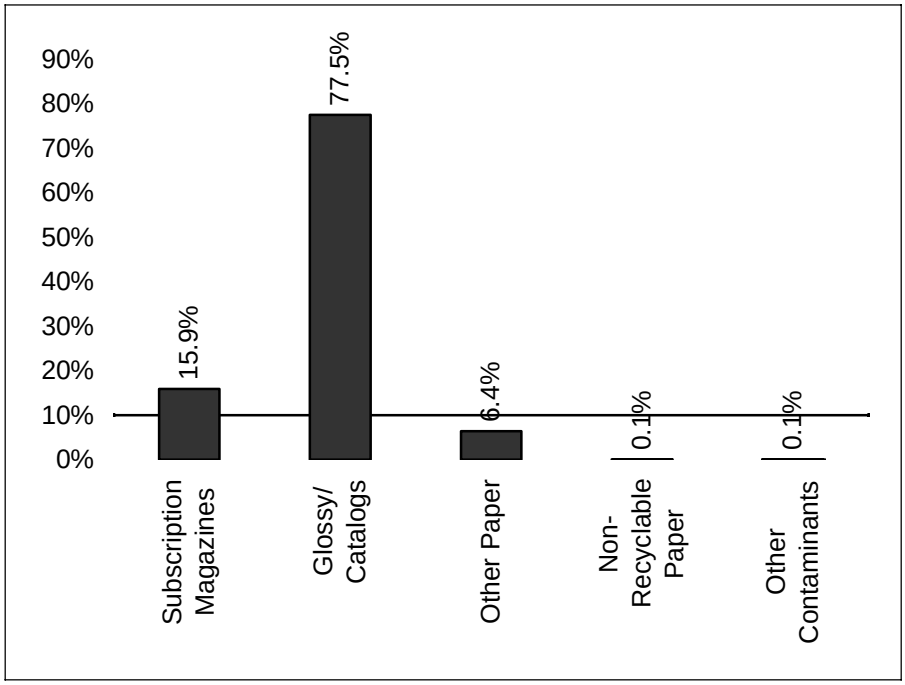
Figures D-9, D-10, D-11, and D-12 show the composition of processed newspaper, magazines, corrugated containers, and office paper respectively. As the figures show, the Recycling Center does a very good job in removing contaminants from the processed material.

Figure D-9
Composition of Processed Newspaper



The Other Contaminants shown in Figure D-9 are film bags.

Figure D-10
Composition of Processed Magazines



The Other Contaminants shown in Figure D-10 are film bags.

Figure D-11
Composition of Processed Corrugated Containers

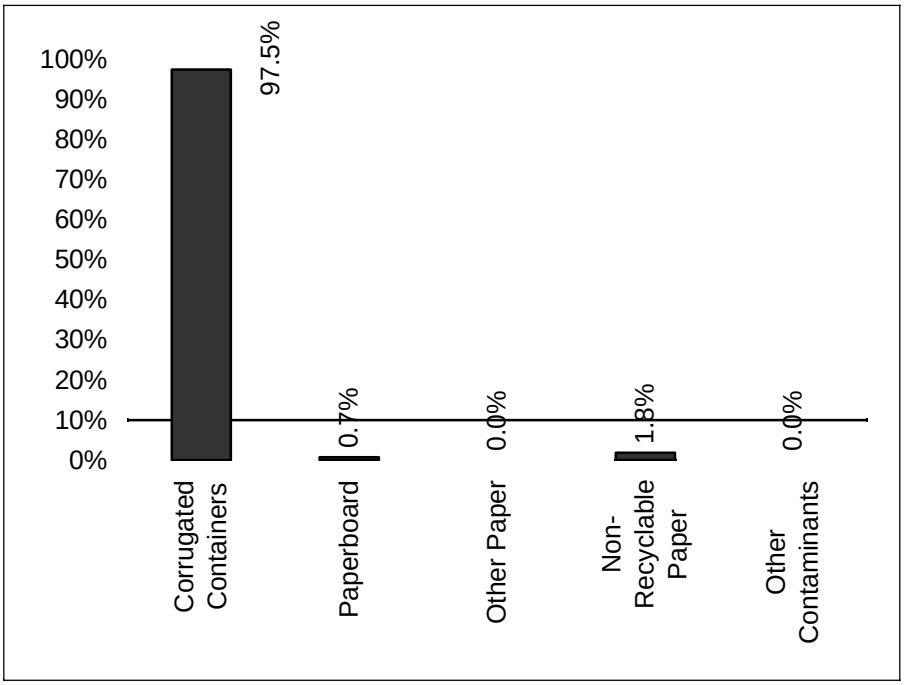
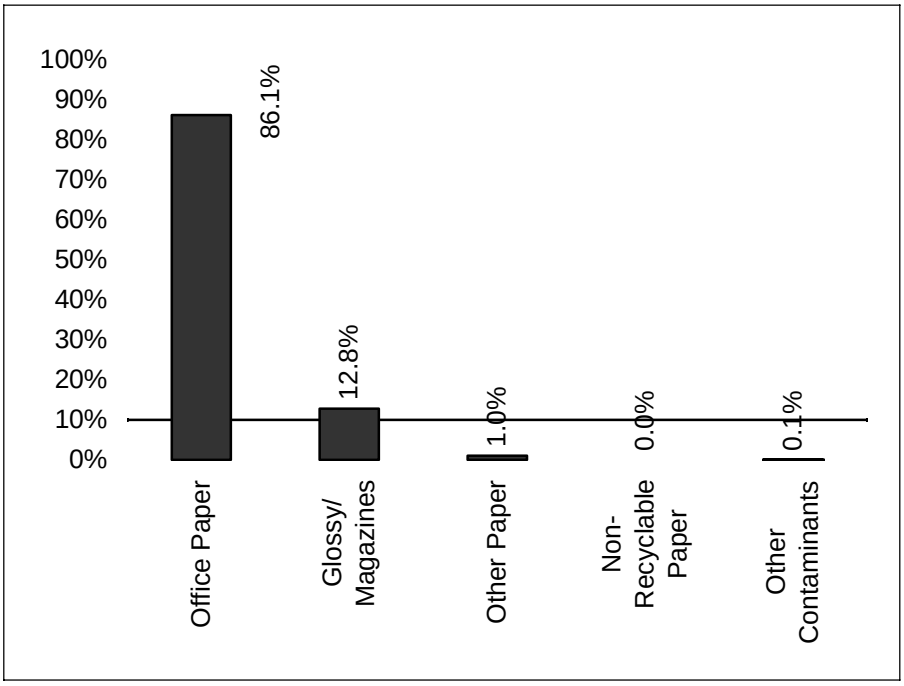


Figure D-12
Composition of Processed Office Paper



The Other Contaminants shown in Figure D-12 are film bags.

D.5 Composition of Rejects and Residues

Figures D-13 and D-14 show the composition of the rejects removed while processing newspapers and containers on the facility's sort line.

Figure D-13
Composition of Sort Line Rejects from Newspaper Processing

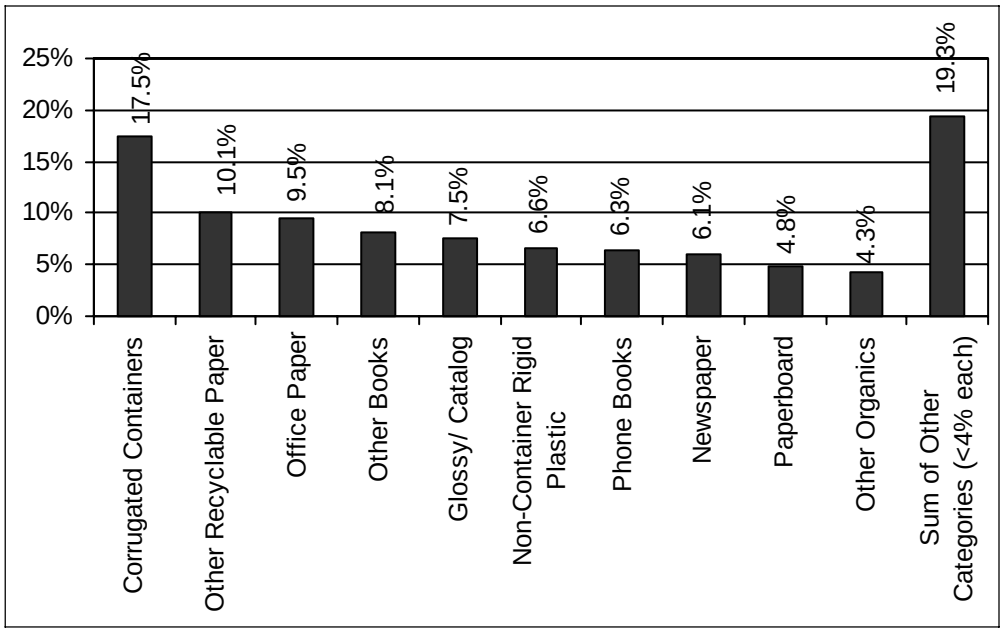
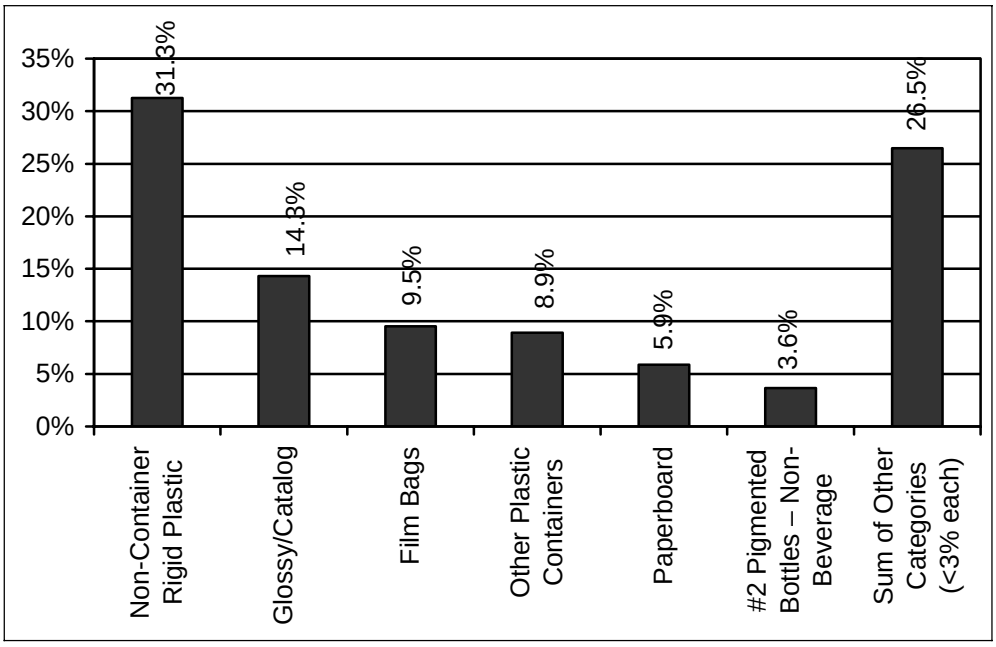
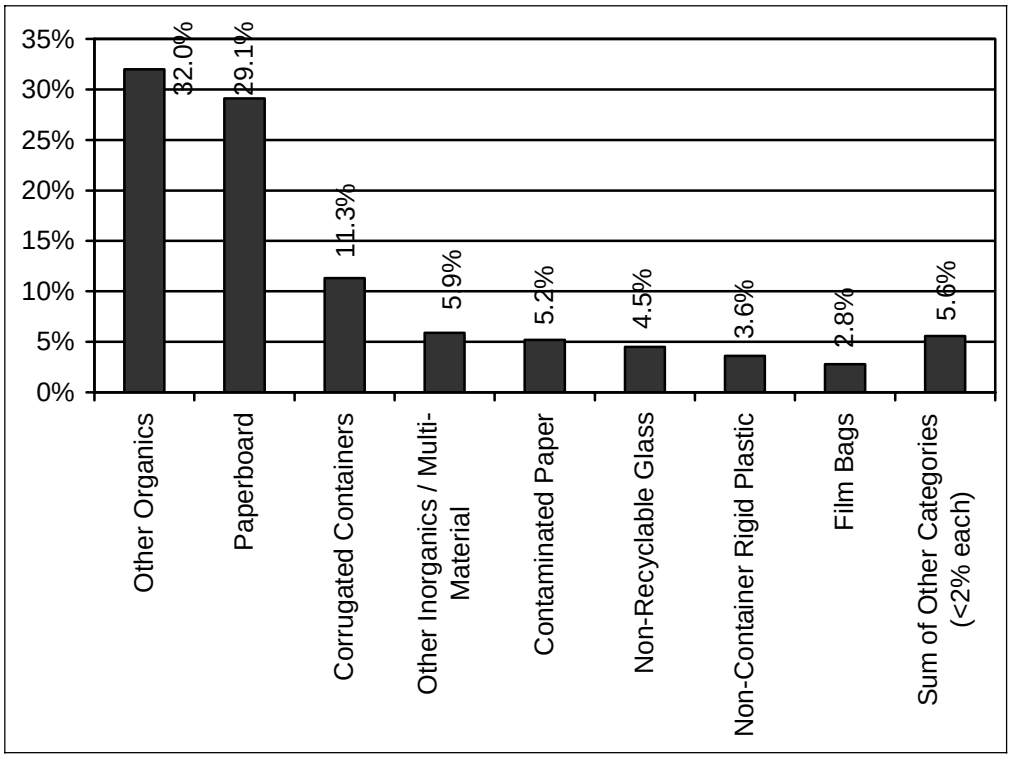


Figure D-14
Composition of Sort Line Rejects from Containers Processing



Corrugated containers are not sorted on the sort line. Instead contaminants are removed from corrugated containers while they are on the tip floor. Figure D-15 shows the composition of the rejects that are removed from OCC.

Figure D-15
Composition of Corrugated Containers Sort Rejects



Appendix E
NORTHERN TIER SOLID WASTE AUTHORITY MRF

E.1 Collection and Processing Overview

The Northern Tier Solid Waste Authority (NTSWA) was created in 1973 as the first regional solid waste authority in Pennsylvania. Since then, NTSWA has strived to meet the solid waste needs of Bradford, Sullivan and Tioga Counties by offering a menu of collection and processing services so that municipalities can select the options that best meet their goals and objectives. Table E-1 shows the sources of incoming materials that the NTSWA MRF processes.[4]

Table E-1
NTSWA MRF Incoming Material Summary

Material Source	Annual Tons (CY01)	Percent of Total
On-Site Drop-Off Center [1]	265	8%
Local Curbside (Curb-Sort) Programs	745	21%
Local Drop-Off Programs	1,210	35%
Commercial Collection	1,270	36%
Total	3,490	100%

1 The on-site drop-off materials are not weighed. This is an estimated quantity.

Because materials are received pre-sorted, there is only limited sorting that is performed at the facility (primarily plastics sorting and contamination picking).

E.2 Sampling Summary

A four-day sampling and sorting event was conducted at the NTSWA MRF on July 15 through 19, 2002. The objective of the sampling event was to investigate the composition of materials as they are received and processed by the MRF. Three specific material streams were included in the sampling and sorting activities:

- Incoming materials from both residential and commercial generators;
- Processed (recovered) materials, such as mixed plastics and mixed paper; and
- Residues and contaminants that were ejected from various points along processing lines at the facility.

[4] The facility also accepts textbooks, clothing/textiles, used motor oil, antifreeze, aluminum foil, clean wood waste, tires, scrap metal/appliances, and occasionally sorted office paper. These materials were not targeted in this study.

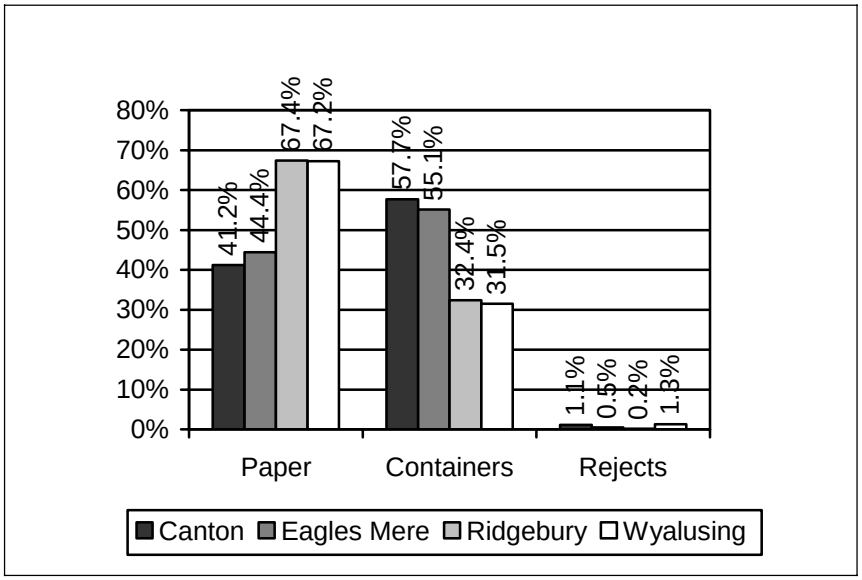
Material samples were taken from each of these three streams using a variety of techniques designed to assure that the samples would be representative. Incoming material samples could have included a representative "scoop" of material, or in some cases may have encompassed an entire incoming truckload to assure that no bias was introduced in the sample. Processed material samples were either taken from broken bales, from the end of conveyor belts, or from material storage containers in the MRF. Residues and contaminants were taken similarly from appropriate ejection points in the facility.

Note that this study intended only to obtain a small number of representative samples from each of the material streams described above. Because of the relatively limited number of samples, the results presented herein are not intended to reflect a statistically comprehensive picture of the material composition of targeted streams. However, this information is nonetheless useful for understanding the composition of material throughout the collection and processing of recyclable materials.

E.3 Composition of Incoming Materials

Figure E-1 summarizes the relative composition of paper, containers, and rejects in incoming materials to the MRF.

Figure E-1
Composition of Incoming Materials



The figure shows significant variation in the composition of incoming materials depending on the community. The boroughs of Canton and Eagles Mere have curb-sort collection programs. The townships of Ridgebury and Wyalusing operate drop-off sites. Figures E-2 through E-5 show additional detail on the composition of incoming material from each of the four municipalities.

Figure E-2
Composition of Canton Borough Incoming Curb-Sort Materials

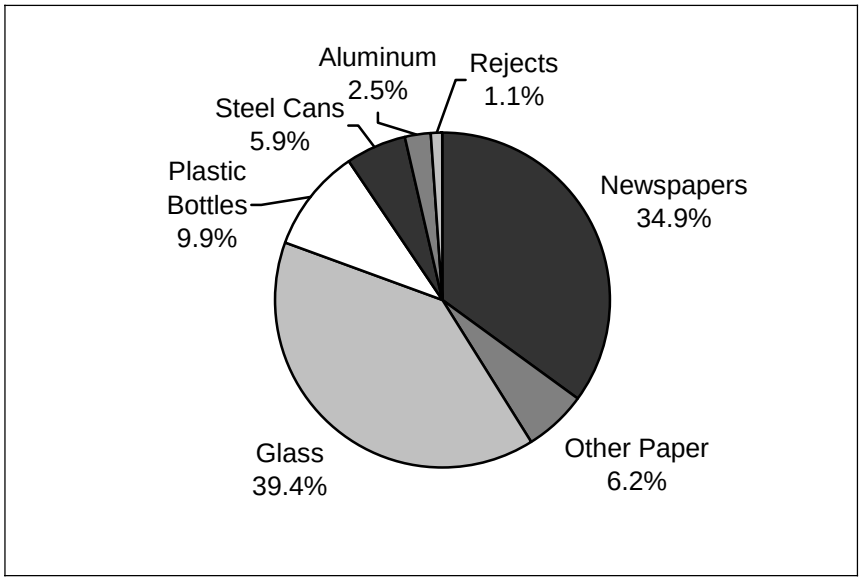


Figure E-3
Composition of Eagles Mere Borough Incoming Curb-Sort Materials

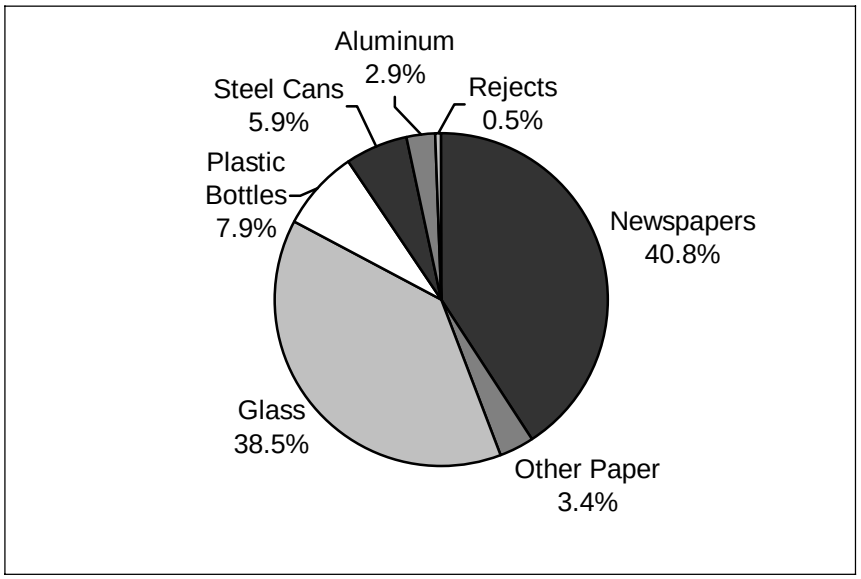


Figure E-4
Composition of Ridgebury Township Incoming Drop-Off Materials

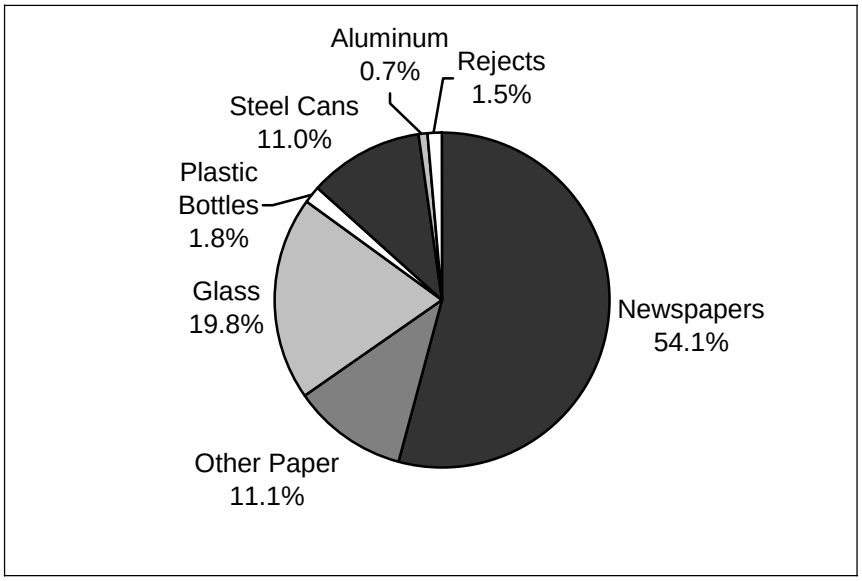
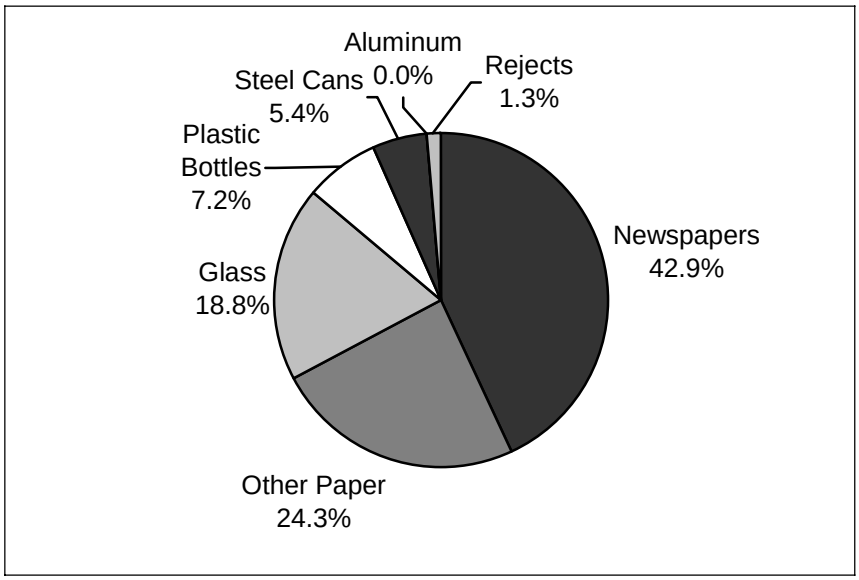


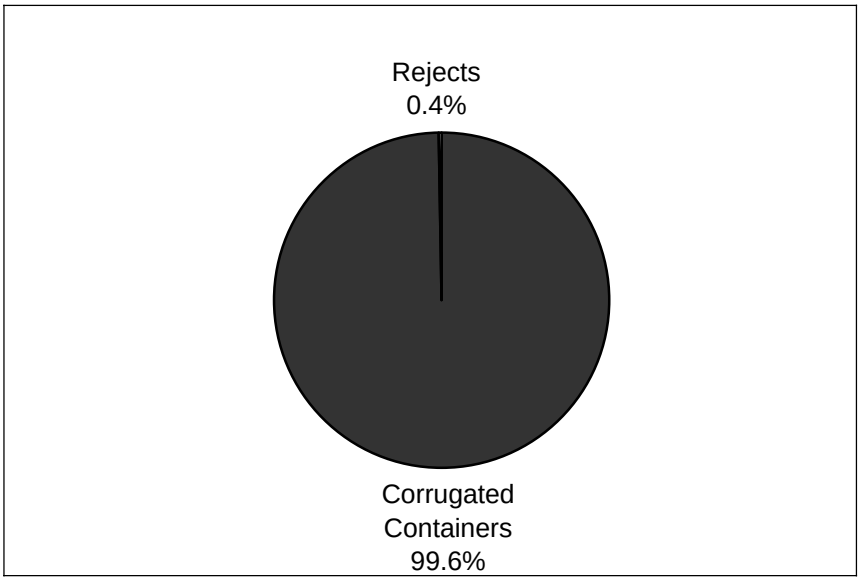
Figure E-5
Composition of Wyalusing Township Incoming Drop-Off Materials



As Figure E-5 shows, the category Other Paper was found to be quite large for incoming material from the Township of Wyalusing. Over half of the material in this category was junk mail.

Figure E-6 shows the composition of incoming corrugated containers from commercial sources. As the figure shows, the material was nearly pure corrugated containers.

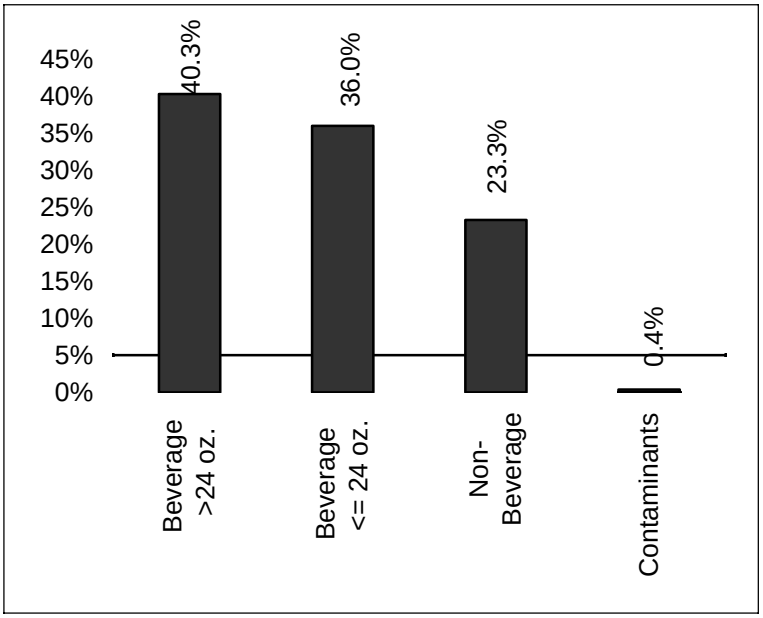
Figure E-6
Composition of Incoming Commercial Corrugated Containers



E.4 Composition of Processed Recyclables

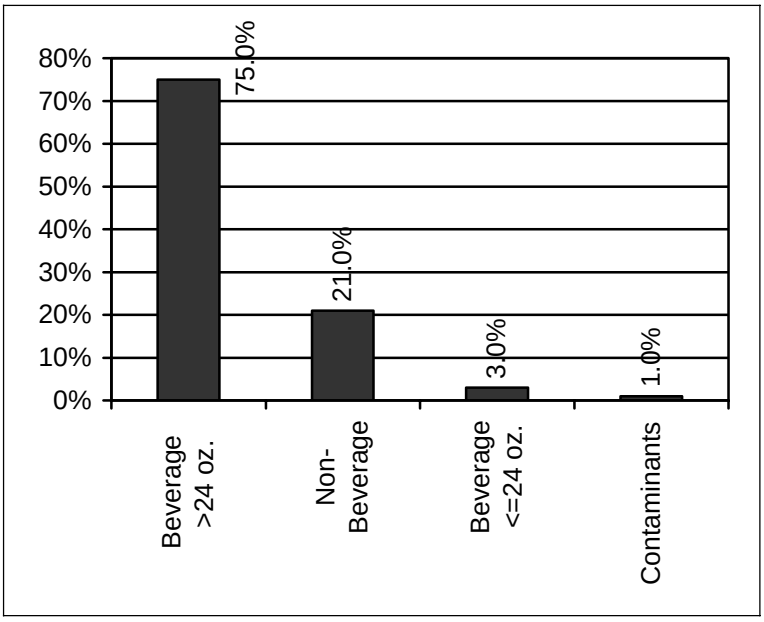
Plastics are positively sorted on the MRF's sorting line into PET, Natural HDPE, and Pigmented HDPE bottle categories. Figures E-7, E-8, and E-9 show the composition of these processed materials.

Figure E-7
Composition of Processed PET Bottles



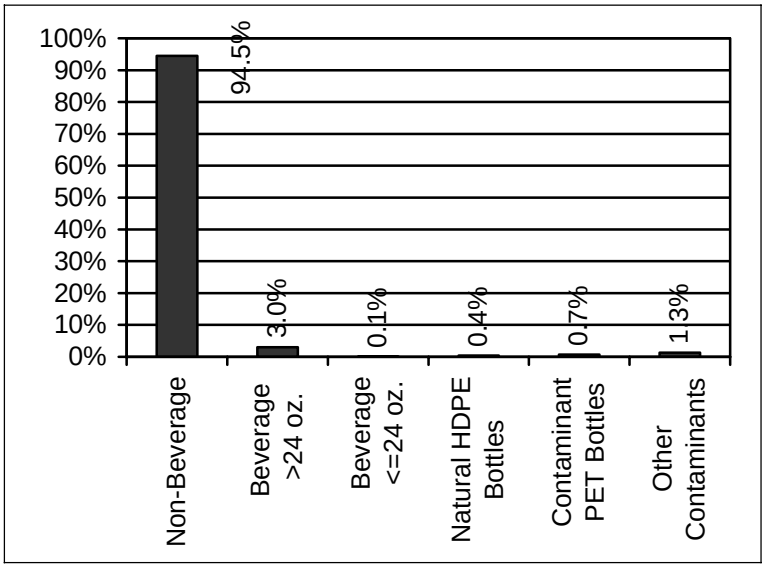
The contaminants shown in Figure E-7 are #3-#7 plastic bottles and pigmented HDPE bottles.

Figure E-8
Composition of Processed HDPE Natural Bottles



The contaminants shown in Figure E-8 are #3-#7 plastic bottles.

Figure E-9
Composition of Processed HDPE Pigmented Bottles

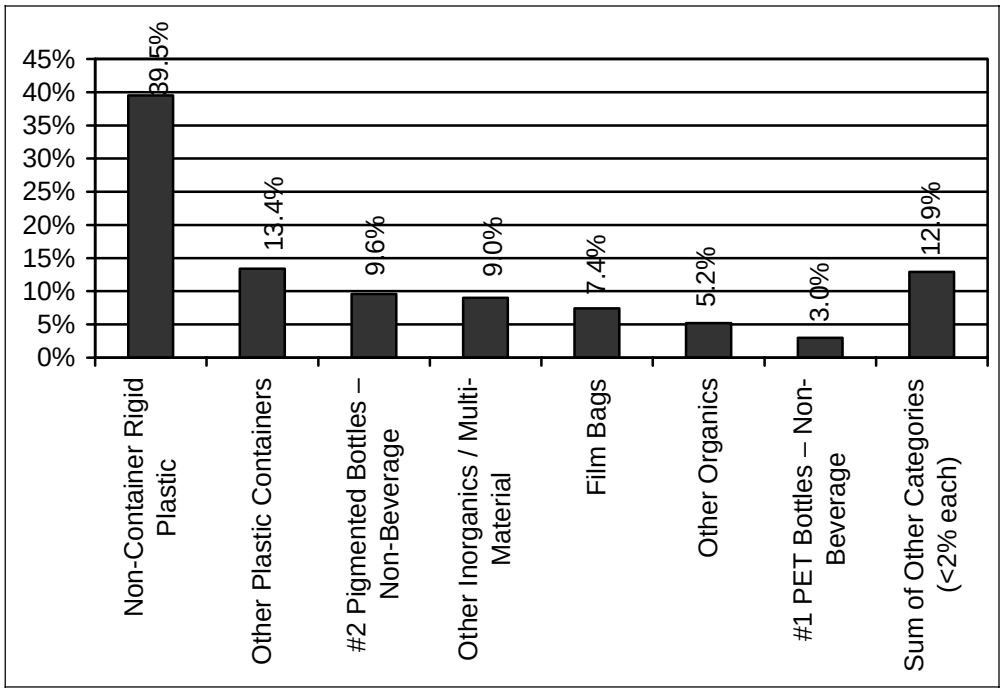


The contaminants shown in Figure E-9 are inorganic or multi-material materials.

E.5 Composition of Rejects and Residues

Figure E-10 shows the composition of residue from the sort line that is used for plastic bottles.

Figure E-10
Composition of Plastic Sort Line Residue



Appendix F
PITTSBURGH RECYCLING MRF

F.1 Collection and Processing Overview

The City of Pittsburgh uses split-body dual-packing rear load trucks to collect curbside recyclables. The larger compartment on the truck is used for collecting commingled containers (aluminum, plastic, glass and steel) which are set out in blue bags. The smaller compartment is for newspapers, which are set out separately in paper bags or bundles. Haulers for other local communities either run two packer trucks on their collection routes (one collects paper, the other containers) or collect two-stream curbside recyclables using standard dual compartment side-loading recycling trucks.

Collected residential recyclables are delivered to Pittsburgh Recycling Services, Inc., a private materials recovery facility. The City of Pittsburgh's blue bag program material nearly equals the amount of residential recyclables that are delivered to the facility from all other local curbside programs. The facility also accepts commercial recyclables (paper). Table F-1 shows the incoming amounts of various streams of materials received at the facility.

Table F-1
Pittsburgh Recycling Incoming Material Summary

Material Source	Monthly Tons (Est. 2002)	Percent of Total
City of Pittsburgh "Blue-Bag" Program	750	26%
Local Curbside Programs (BFI & WM)	800	27%
Local Drop-off Programs	100	3%
Commercial Collection	775	27%
Paper Companies	500	17%
Total	2,925	100%

F.2 Sampling Summary

A four-day sampling and sorting event was conducted at the Pittsburgh Recycling MRF on September 9 through September 12, 2002. The objective of the sampling event was to investigate the composition of materials as they are received and processed by the MRF. Three specific material streams were included in the sampling and sorting activities:

- Incoming materials from both residential and commercial generators;
- Processed (recovered) materials, such as mixed plastics and mixed paper; and
- Residues and contaminants that were ejected from various points along processing lines at the facility.

Material samples were taken from each of these three streams using a variety of techniques designed to assure that the samples would be representative. Incoming material samples could have included a representative "scoop" of material, or in some cases may have encompassed an entire incoming truckload to assure that no bias was introduced in the sample. Processed material samples were either taken from broken bales, from the end of conveyor belts, or from material storage containers in the MRF. Residues and contaminants were taken similarly from appropriate ejection points in the facility.

Note that this study intended only to obtain a small number of representative samples from each of the material streams described above. Because of the relatively limited number of samples, the results presented herein are not intended to reflect a statistically comprehensive picture of the material composition of targeted streams. However, this information is nonetheless useful for understanding the composition of material throughout the collection and processing of recyclable materials.

F.3 Composition of Incoming Materials

Figure F-1 shows the composition of incoming residential paper from the City of Pittsburgh's recycling program. Pittsburgh accepts only newspapers and their inserts, which must be tied or placed into brown paper bags – no other paper is accepted. The corrugated containers fraction shown in Figure F-1 is actually brown Kraft bags.

Figure F-1
Composition of City of Pittsburgh Incoming Newspapers

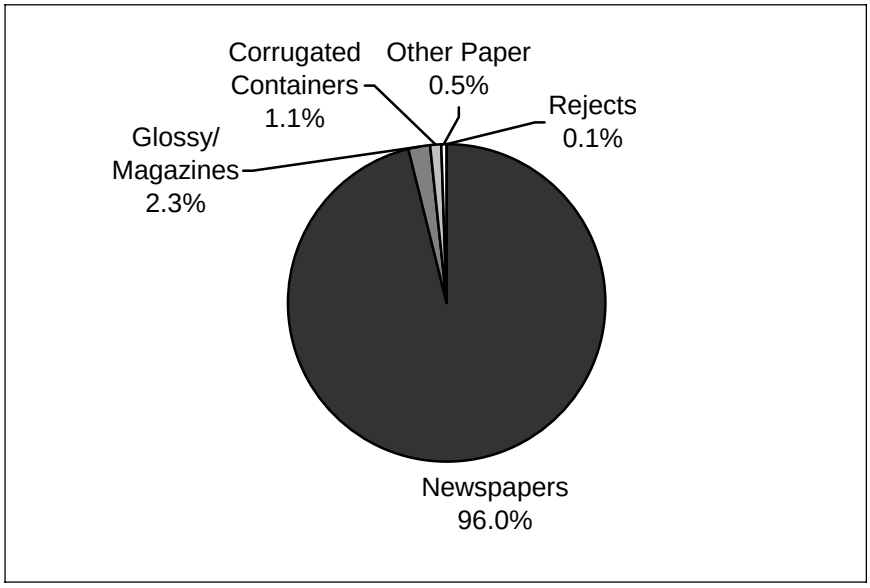


Figure F-2 shows the composition of containers from the City of Pittsburgh. Residents are encouraged to recycle all glass containers, plastic bottles and jars labeled #1 and #2, all cans, and aluminum foil. It is noteworthy that a fairly large amount of paper is either placed by program participants in this containers stream, or is mixed during the collection and/or tipping of the materials.

Figure F-2
Composition of City of Pittsburgh Incoming Blue Bag Containers

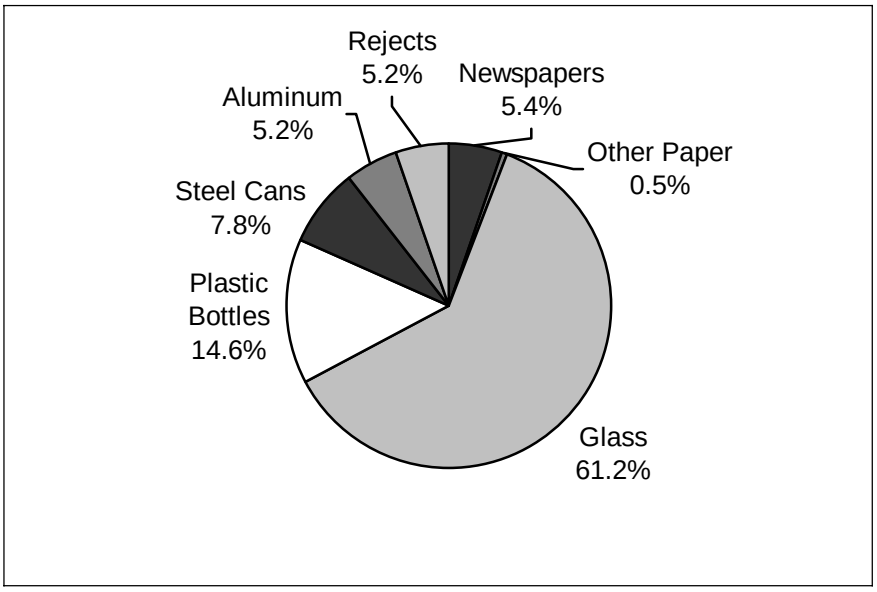


Figure F-3 and F-4 shows the composition of incoming curbside collected containers from the Municipalities of Bethel Park and Monroeville, respectively. These municipalities use bins and not bags, resulting in lower levels of rejects and improperly set out newspapers that were observed in material received from Pittsburgh's blue bags.

Figure F-3
Composition of Municipality of Bethel Park Incoming Curbside Containers

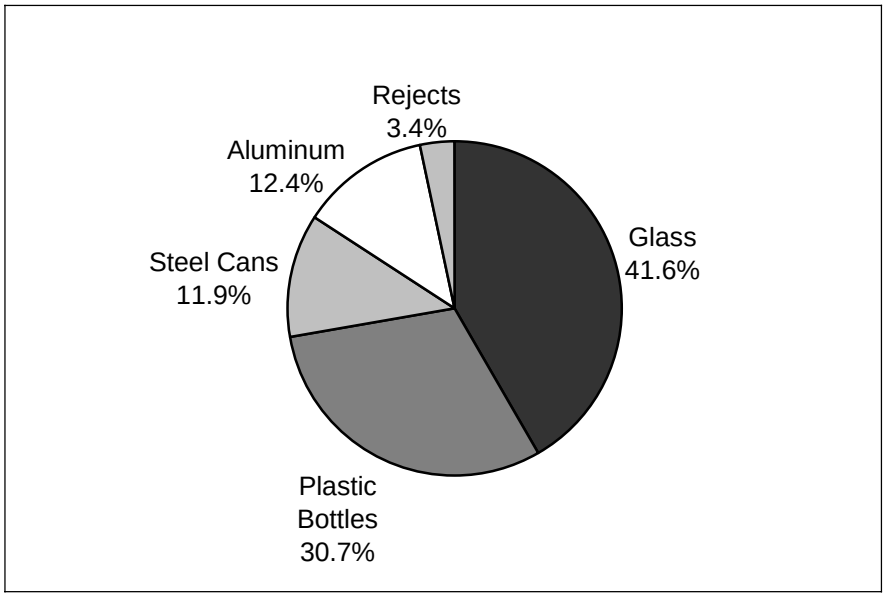


Figure F-4
Composition of Municipality of Monroeville
Incoming Curbside Containers

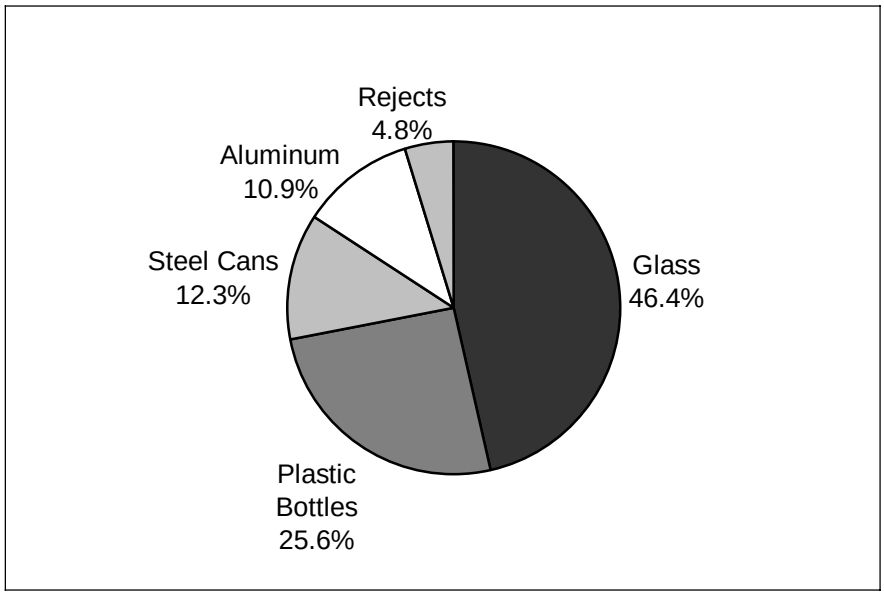


Figure F-5 shows the composition of incoming curbside collected residential paper from the Municipality of Penn Hills. Penn Hills accepts all forms of residential paper that have not been contaminated by food. Paper is supposed to be set out bundled or in brown paper bags.

Figure F-5
Composition of Municipality of Penn Hills
Incoming Residential Paper Materials

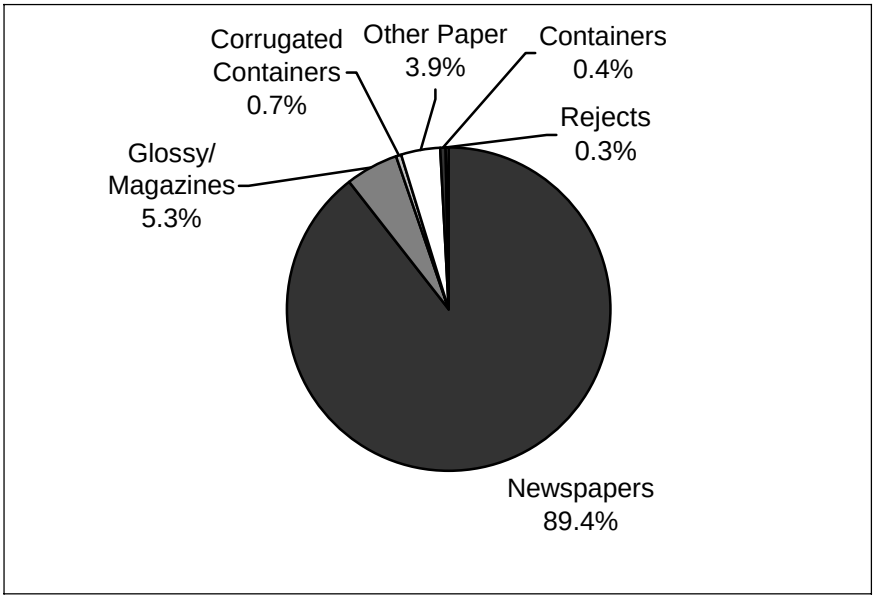


Figure F-6 and F-7 show the composition of incoming commercial corrugated containers and office paper, respectively.

Figure F-6
Composition of Incoming Commercial Corrugated Containers

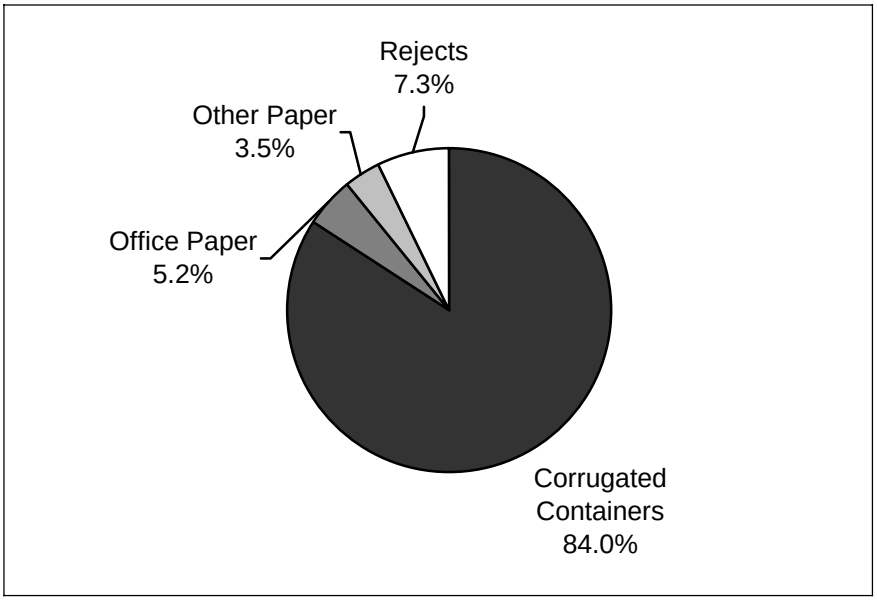
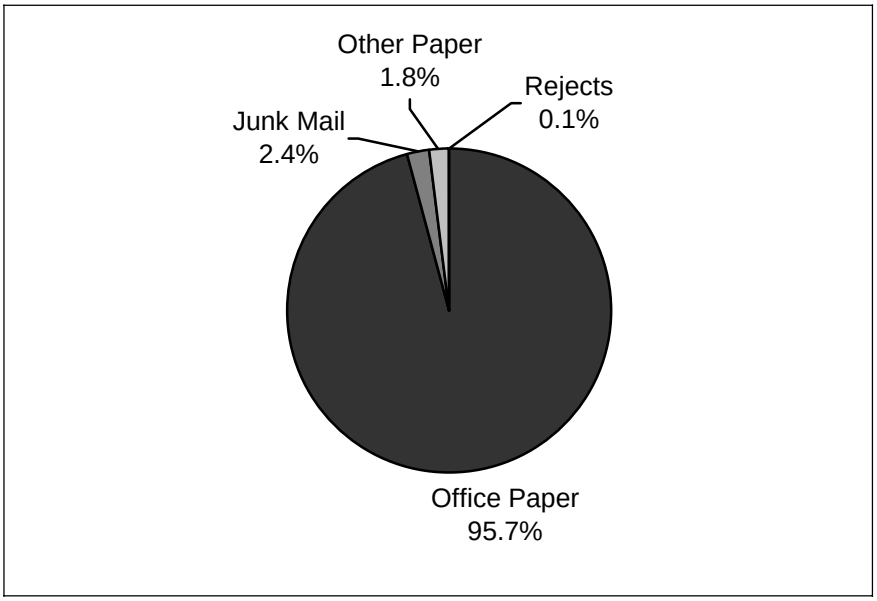


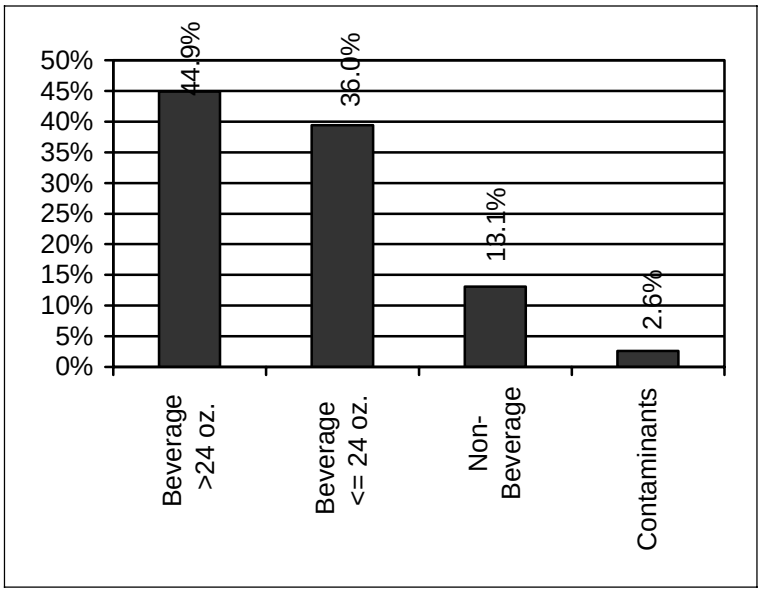
Figure F-7
Composition of Incoming Commercial Office Paper



F.4 Composition of Processed Recyclables

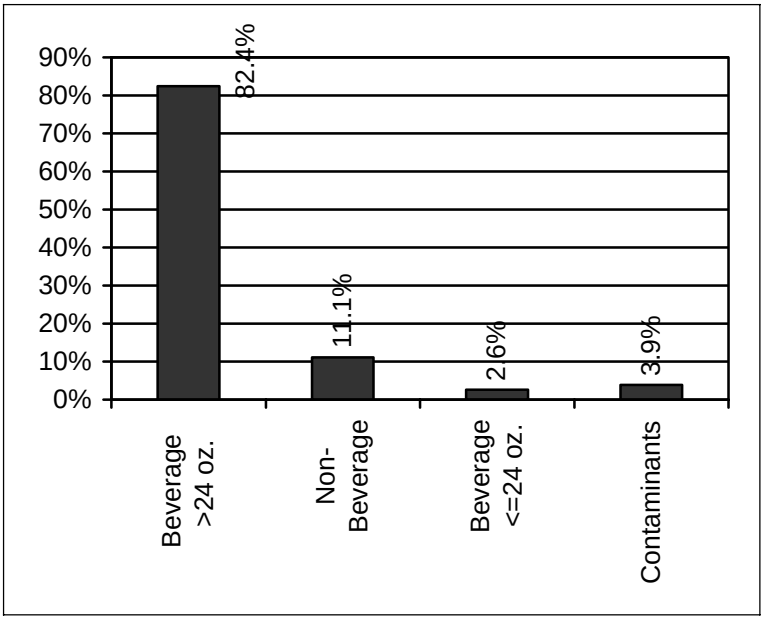
The composition of processed PET bottle and Natural HDPE bottle bales are shown in Figures F-8 and F-9, respectively. These grades of plastics are positively sorted.

Figure F-8
Composition of Processed PET Bottles



The contaminants shown in Figure F-8 are non-bottle plastics, #3-#7 plastic bottles, and aluminum cans.

Figure F-9
Composition of Processed HDPE Natural Bottles



The contaminants shown in Figure F-9 are #3-#7 plastic bottles, non-bottle plastics, and pigmented bottles.

Figure F-10 shows the composition of a bale of pigmented HDPE bottles. This grade is negatively sorted and is composed of what remains on the sort belt after other materials have been sorted out, resulting in increased contamination levels. Contaminant Other Plastics is primarily non-container plastics with minor amounts of non-bottle plastic containers and #3-#7 plastic bottles. Other Contaminants is aluminum cans and magazines.

Figure F-10
Composition of Processed HDPE Pigmented Bottles

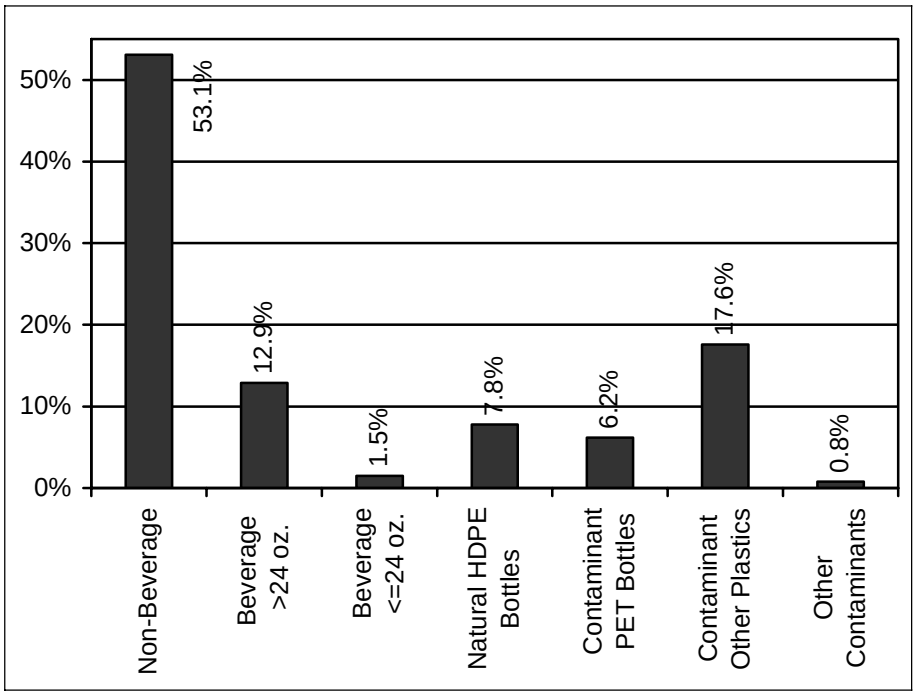
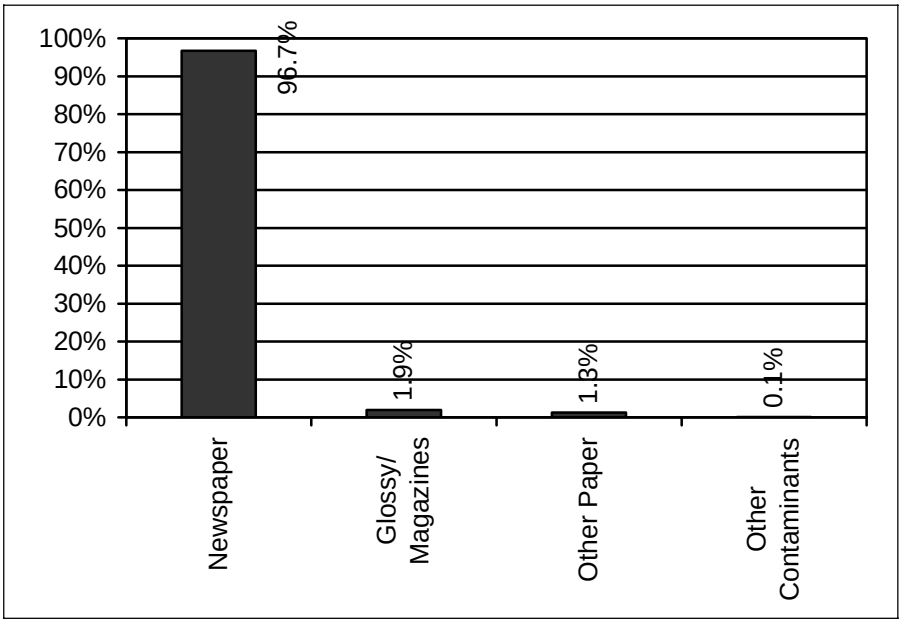


Figure F-11 shows the composition of negatively sorted newspaper.

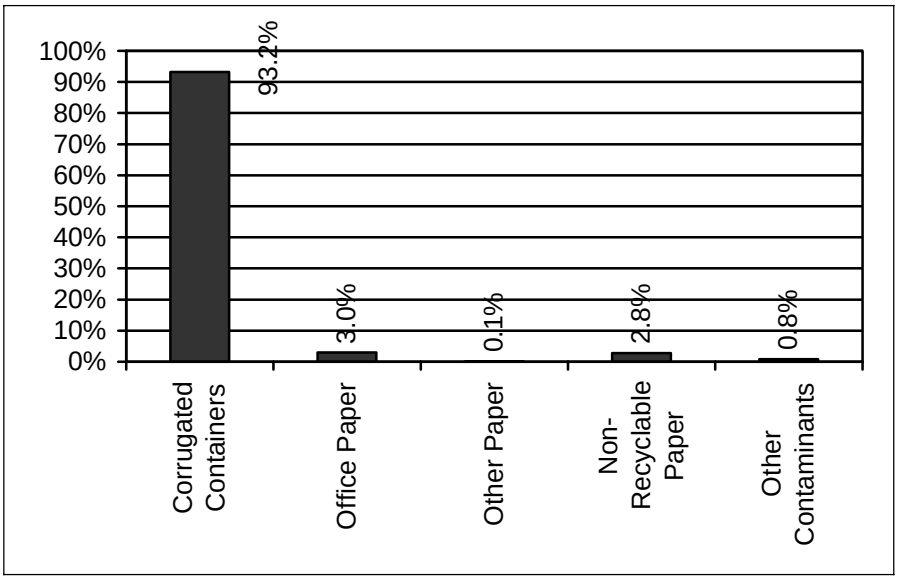
Figure F-11
Composition of Processed Newspaper



Other Contaminants in Figure F-11 are film bags.

Figure F-12 shows the composition of processed corrugated containers that come from commercial sources.

Figure F-12
Composition of Processed Corrugated Containers

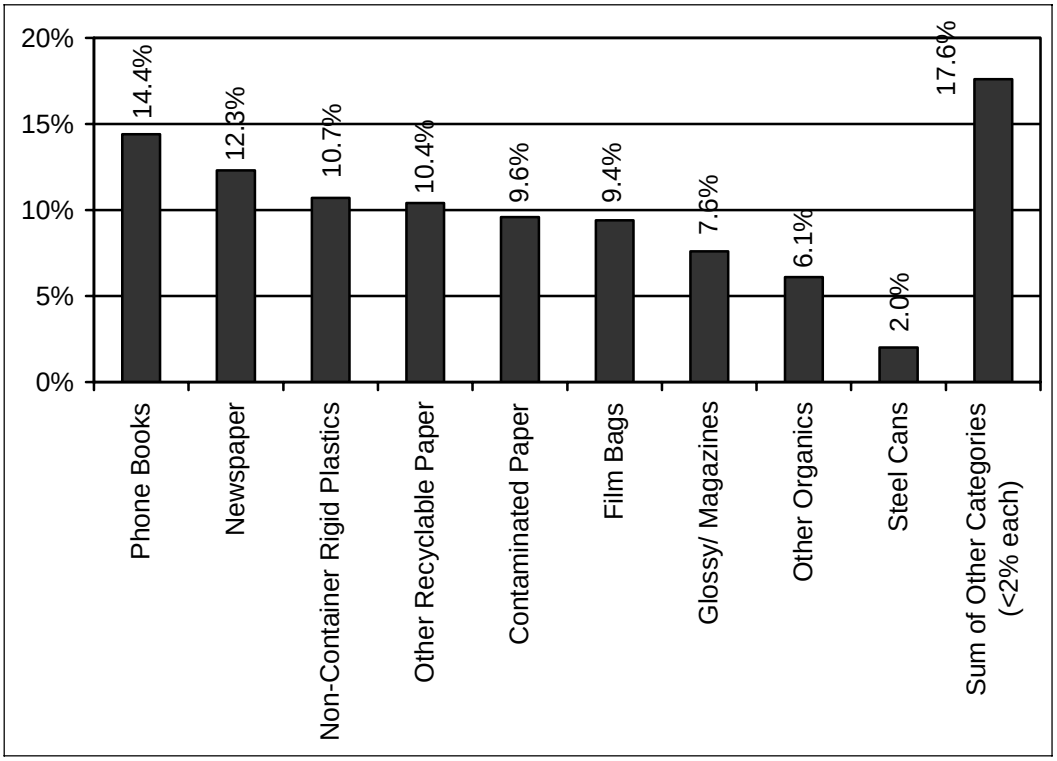


Other Contaminants in Figure F-12 are non-container rigid plastics.

F.5 Composition of Rejects and Residues

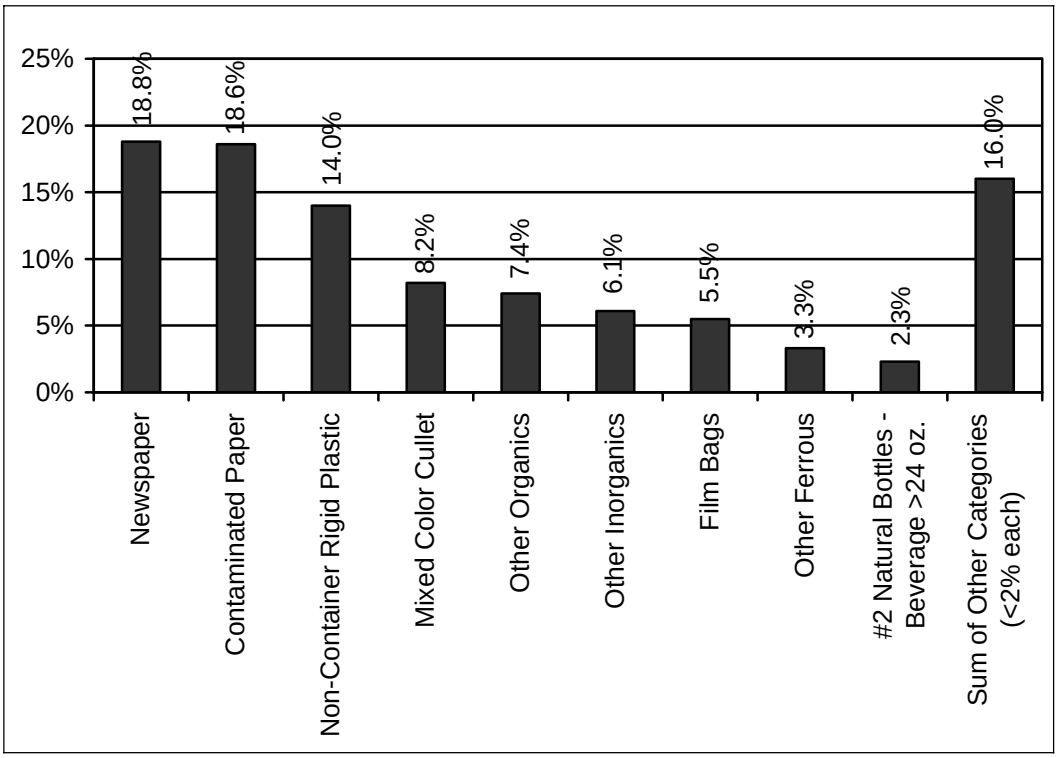
There are four ejection points in the facility where rejects or residues are removed from the processed material. The first is at the fiber line sorting stations where rejects are positively sorted out. The composition of these rejects is shown in Figure F-13.

Figure F-13
Composition of Fiber Line Rejects



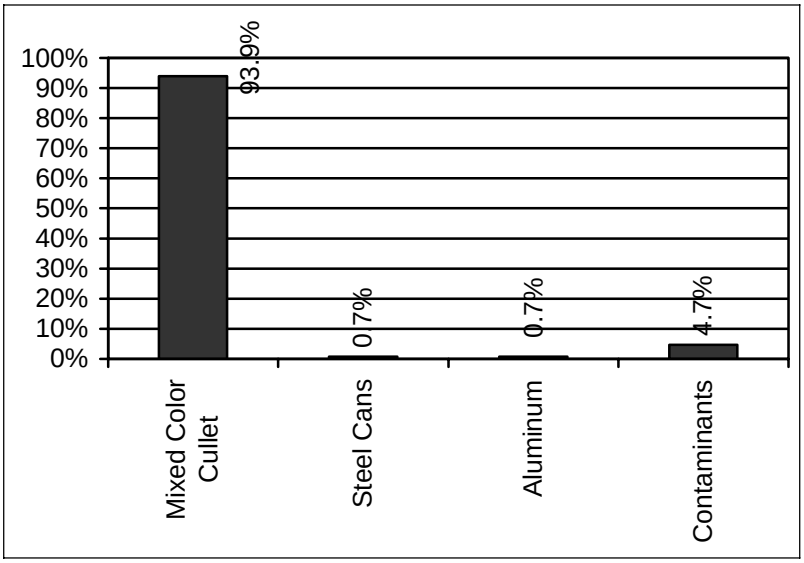
At the start of the containers sort line is a debagging station where blue bags and other contaminants are positively removed. The composition of these rejects is shown in Figure F-14.

Figure F-14
Composition of Rejects from Start of Commingled Line



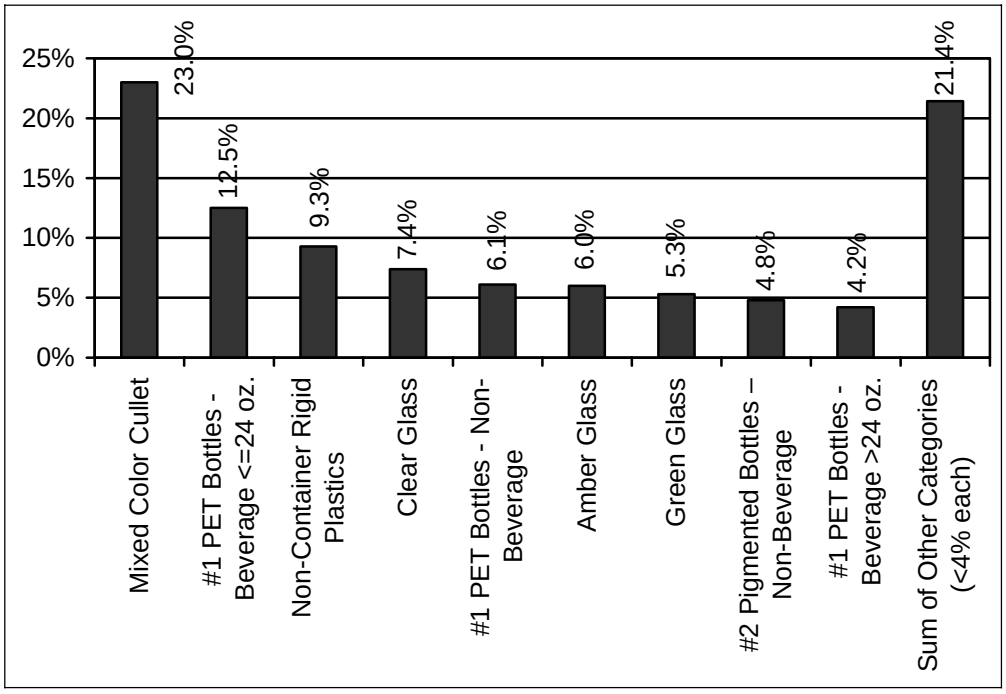
Commingled containers then pass over a shaker screen that separates out mixed color cullet and other small items. Figure F-15 shows the composition of this residue.

Figure F-15
Composition of Shaker Screen Residue



After the shaker screen the containers are separated into heavy and light fractions by an air classifier. The light fraction (composed of plastics and cans) undergoes additional separation – because pigmented HDPE bottles are negatively sorted from the lights sort line, there is no residue from that line. However, three colors of glass are positively sorted from the heavy fraction line. The residue from this line has the composition shown in Figure F-16.

Figure F-16
Composition of Glass Sort Line Residue



G.1 Collection and Processing Overview

The Todd Heller, Inc. Materials Recovery Facility serves as a regional processing center for residential dual stream, mixed and sorted glass cullet, and commercial OCC that come from a range of sources. The facility also accepts recyclables (mostly commingled containers) from transfer stations in PA and NJ. This study is only focused on recyclables generated in PA. Table G-1 summarizes the relative amounts of commingled containers and paper Todd Heller, Inc. processes from Pennsylvania.

Table G-1
Incoming Material Summary

Material Type	Total Incoming Estimated PA Monthly Tons	Total Incoming Estimated NJ Monthly Tons	Percentage Composition
Commingled Containers	5,000	N/A	89%
Paper	600	N/A	11%
Grand Total	5,600		100%

N/A — data not available

The majority of the recovered materials delivered to the facility are generated from residential recycling programs. Todd Heller, Inc. currently collects roll-off containers from drop-off recycling locations across Southeastern Pennsylvania. Some Pennsylvania Counties also deliver curbside and drop-off recyclables to the facility. The facility also accepts curbside recyclables and OCC from private sector recyclers.

The commingled container stream accepted by Todd Heller, Inc. includes PET and HDPE plastic bottles, three colors of glass, and aluminum & steel cans. The facility also handles fibers such as ONP, and OCC.

Processing is performed in the following manner at the facility:

- **Tip Floor:** All incoming material is tipped on a central tip floor. Commingled containers, ONP, and OCC fiber streams are pushed into separate piles on different areas of the tip floor. Incoming loads of only glass are tipped onto a separate tip floor in a different building that is for glass processing.
- **Manual Commingled Sort:** Commingled containers are pushed onto a conveyor, which feeds an elevated sorting platform. The sort employees positively sort the glass, plastics, and metals. Contaminants/residue goes off the end of the conveyor belt. Sorted materials are stored in bunkers for later baling, except for the glass which is further processed on site.

- **Manual Fiber Sorting:** On the fiber side of the facility, ONP and OCC fiber streams are separately pushed onto an incline conveyor leading to an elevated sorting platform. The fiber material is negatively sorted and proceeds directly to the baler after removal of contaminants. The contaminants are dropped into bunkers below the sort line for future baling as a different grade of paper or disposal.
- **Glass Processing:** Separated glass is dumped on the tip floor and pushed onto a feed conveyor that moves the glass to a glass crusher. The crushed glass is stored in bunkers outside the building for future sales.

G.2 Sampling Summary

A four-day sampling and sorting event was conducted at the Todd Heller, Inc. MRF from April 20-23, 2004. The objective of the sampling event was to investigate the composition of materials as they are received and processed by the MRF. Three specific material streams were included in the sampling and sorting activities:

- Incoming materials from both residential and commercial generators;
- Processed (recovered) materials, such as mixed plastics and newspaper; and
- Residues and contaminants that were ejected from various points along processing lines at the facility.

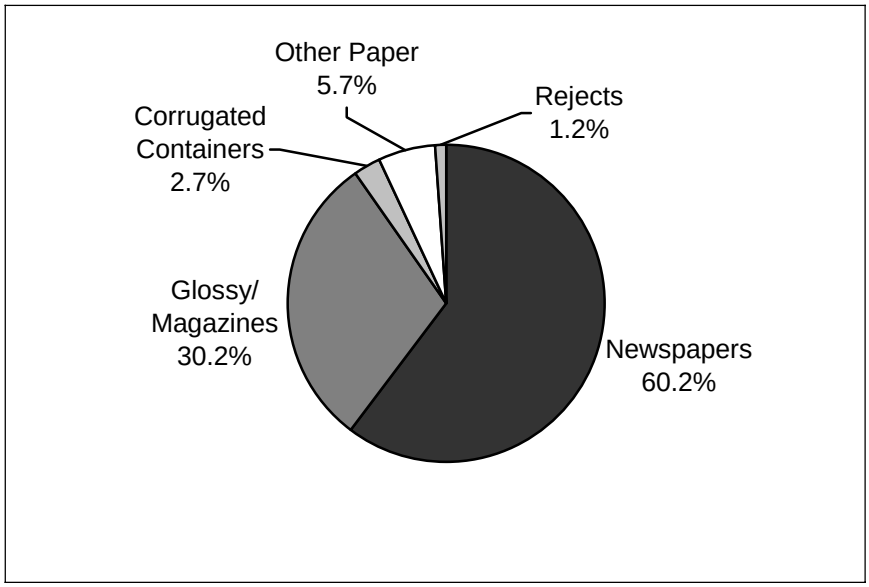
Material samples were taken from each of these three streams using techniques designed to assure that the samples would be representative. Incoming material samples included a representative "scoop" of material. Processed material samples were either taken from broken bales, from the end of conveyor belts, or from material storage containers in the MRF. Residues and contaminants were taken similarly from appropriate ejection points in the facility. Sample sizes were targeted for 250 to 300 pounds.

This study intended to obtain samples primarily from incoming materials, with several samples reserved for processed materials and rejects and residues. This sampling plan was selected to provide the best statistical confidence on data from incoming material.

G.3 Composition of Incoming Materials

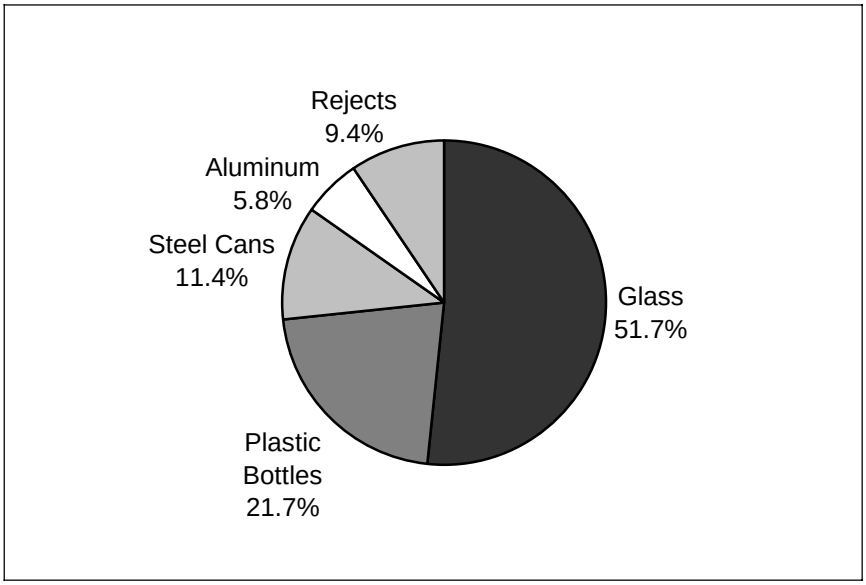
Figures G-1 and G-2 show the composition of residential paper and containers that are collected from nearby communities and delivered to the MRF.

Figure G-1
Composition of Incoming Curbside-Collected Residential Paper



Note: composition based on eleven samples

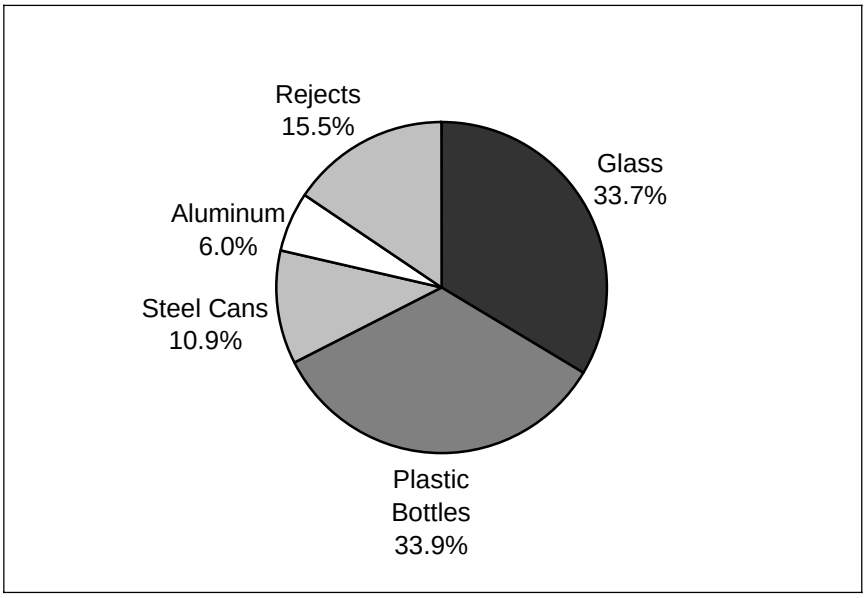
Figure G-2
Composition of Incoming Curbside-Collected Containers



Note: composition based on ten samples

Figure G-3 shows the composition of incoming containers that are delivered by transfer trailer to the MRF.

Figure G-3
Composition of Incoming Transferred Containers



Note: composition based on ten samples

As Figure G-3 shows, the amount of rejects that are delivered by transfer trailer to the MRF are quite high at 15.5 percent.

Figure G-4 shows the composition of incoming commercial office paper from Allentown and Figure G-5 shows the composition of incoming commercial corrugated containers.

Figure G-4
Composition of Incoming Allentown Commercial Office Paper

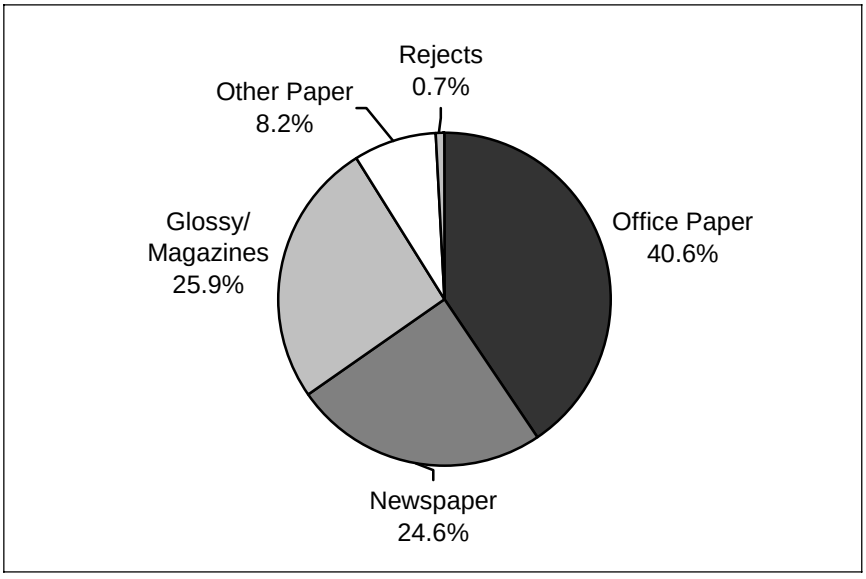
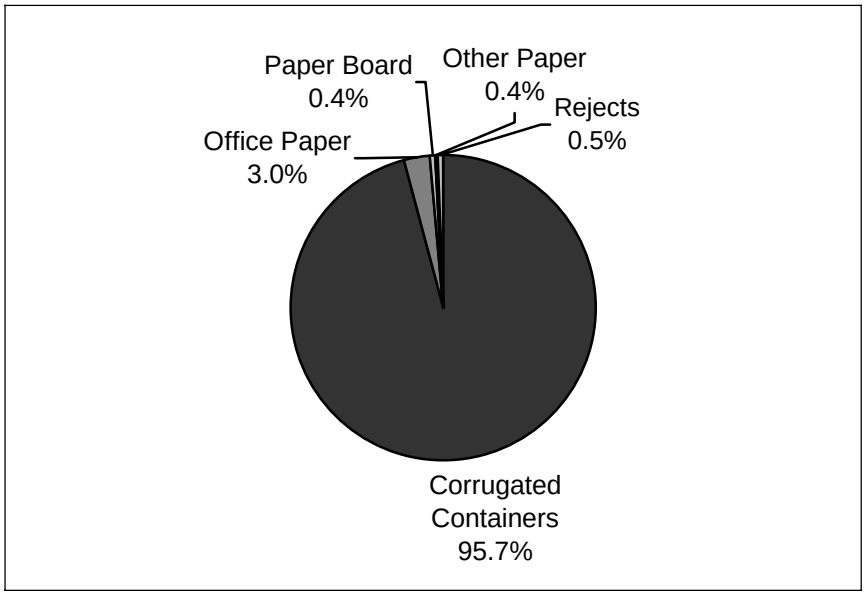


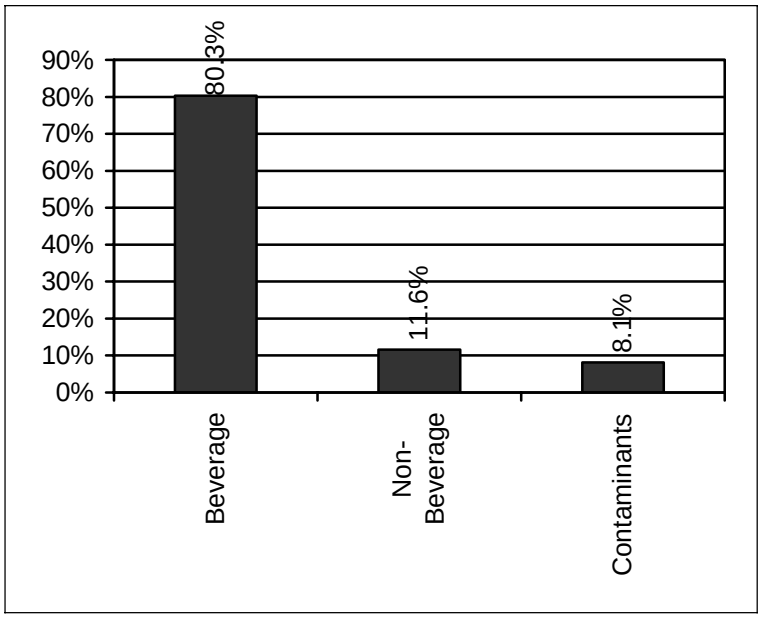
Figure G-5
Composition of Incoming Corrugated Containers



G.4 Composition of Processed Recyclables

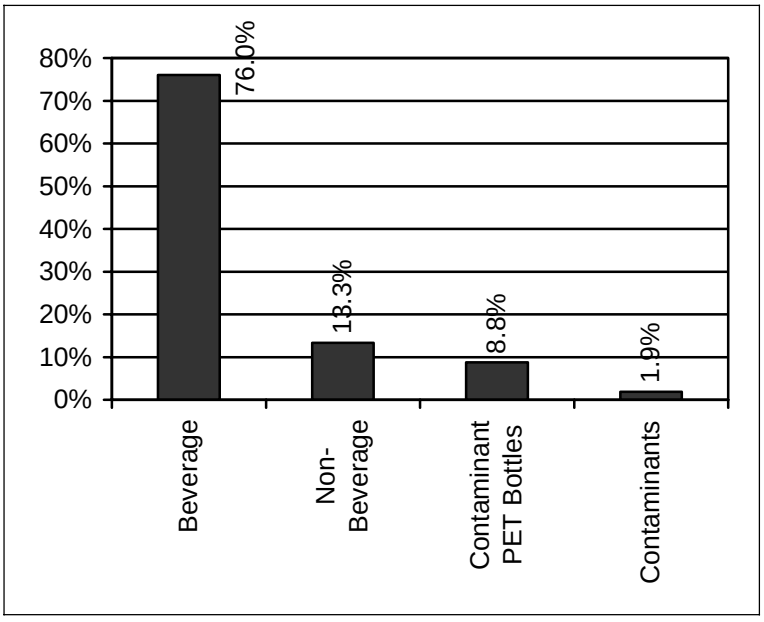
Figures G-6, G-7, and G-8 show the composition of processed PET bottles, HDPE natural bottles, and HDPE pigmented bottles.

Figure G-6
Composition of Processed PET Bottles



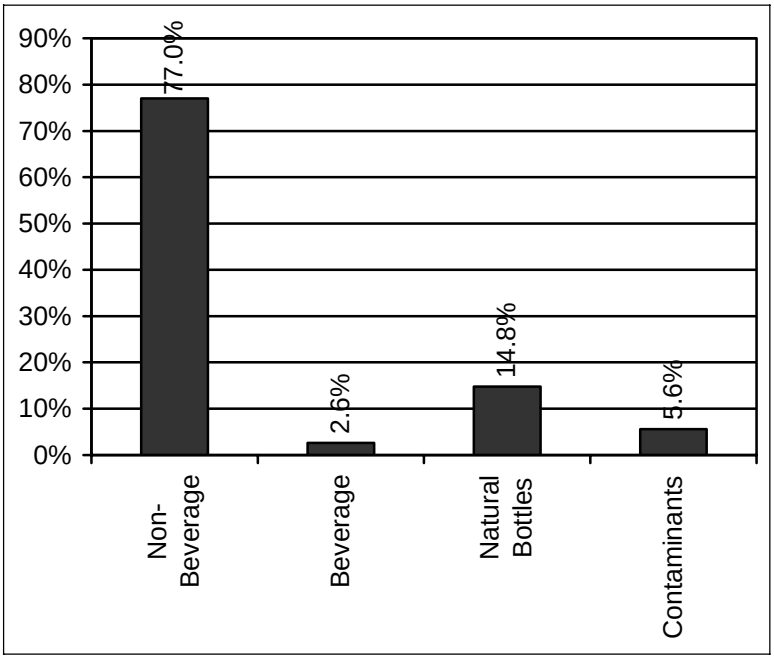
Contaminants shown in Figure G-6 are an assortment of HDPE bottles, aluminum cans, film bags, #3-#7 plastic bottles, non-bottle plastics, and non-recyclable paper.

Figure G-7
Composition of Processed HDPE Natural Bottles



Contaminants shown in Figure G-7 are pigmented HDPE bottles, film bags, #3-#7 plastic bottles, and non-bottle plastics.

Figure G-8
Composition of Processed HDPE Pigmented Bottles

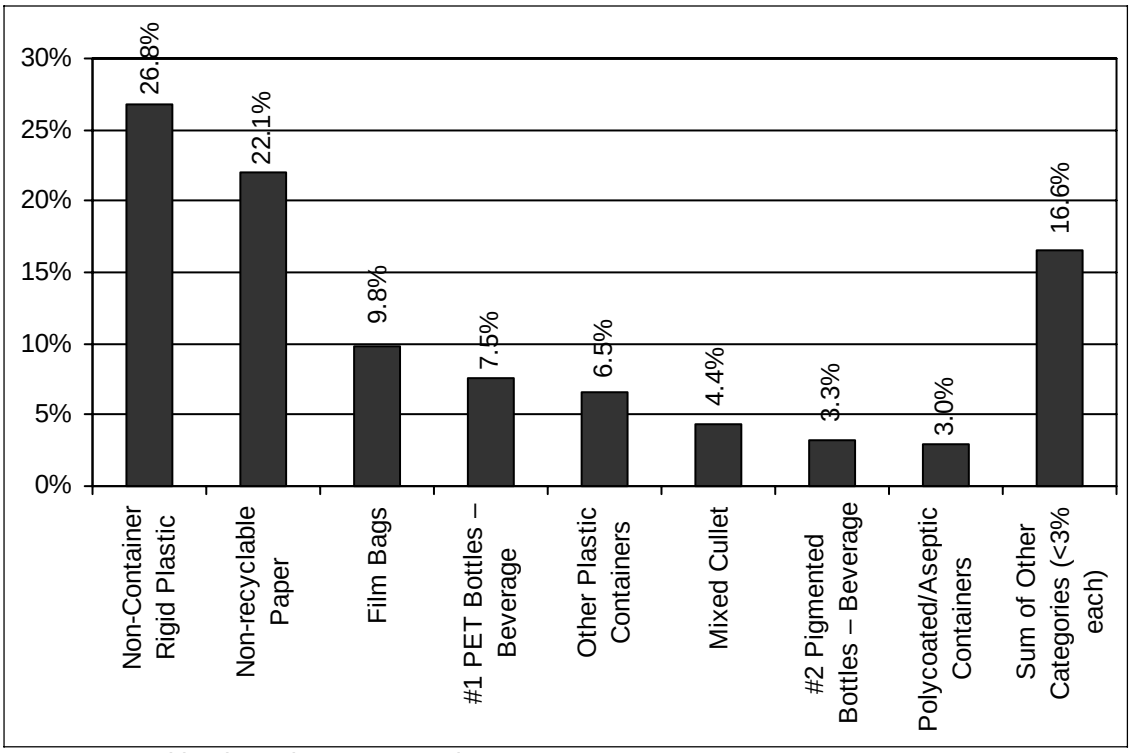


Contaminants shown in Figure G-8 are #3-#7 plastic bottles, PET bottles, and non-bottle plastics. It should be noted that the natural HDPE bottles shown in the figure are not normally considered to be a contaminant to the pigmented HDPE grade of processed plastics.

G.5 Composition of Rejects and Residues

Figure G-9 shows the composition of residue from the commingled containers sort line. As the figure shows, the majority of residue is non-bottle plastics.

Figure G-9
Composition of Residue from Containers Sort Line



Note: composition based on two samples

H.1 Collection and Processing Overview

Approximately 80 percent of York County's population is covered by curbside recycling programs, which are offered by 50 out of 72 municipalities in the County. Several drop-off sites are also maintained for households without curbside collection of recyclables.

The Recycle America of York Recycling Center serves as a regional MRF and processes source-separated, dual stream and single stream recyclables (i.e., fibers and containers are mixed together in the incoming truckload) from a range of sources. Half of all material processed at the facility is delivered by transfer trailers that come from Cumberland, Dauphin, Lebanon, and Lancaster Counties. Two-thirds of materials arrive at the facility as single stream, as shown in Table H-1.

Table H-1
Incoming Material Summary

Material Type	Average Monthly Quantity (Tons)	Percentage Composition
3 Mix Glass	8.09	0.2%
Commingled containers	167.95	3.4%
Commingled containers & ONP	1,079.76	21.9%
Commingled containers, ONP, OCC	54.57	1.1%
Commingled drop-off containers	35.48	0.7%
Loose OCC	283.12	5.7%
Single Stream containers and fiber	3,304.02	67.0%
Grand Total	4,932.99	100.0%

Note: based on November 2003 to January 2004 average data

Although this MRF receives primarily single stream material, not all of the single stream material is actually collected from the curb in a single stream fashion. Rather, many recycling programs that collect material for this facility use dual stream curbside collection systems that remain from before the MRF was retrofitted to receive single stream recyclables in early 2002. The collection systems segregate ONP and fibers in one compartment of the collection vehicles, and commingled containers in another compartment. Sunk capital costs for recycling equipment, resident/collection crew loading habits, and/or the desire for flexibility to deliver material to other recycling processors may be the reason why communities continue to collect recyclables that are more or less segregated into two streams of recyclables. This is particularly the case for materials that are delivered by transfer trailer.

Four transfer sites deliver a significant amount of the materials that are received by the MRF:

1. Lancaster County Solid Waste Management Authority delivers material by transfer trailers from its member communities. The communities choose the materials that they collect in their programs. All communities collect glass, newspaper, aluminum cans, and steel cans — #1 and #2 plastic bottles are optional, but most communities include them. A portion of the communities also collect corrugated containers or magazines. Residents set materials out in two streams (fiber and containers) and the decision of whether to maintain the separation (or load the collection vehicle single stream) is left to the hauler.
2. The City of Harrisburg delivers transfer trailers of only containers. PET and HDPE bottles, steel cans, aluminum cans, and clear, brown and green glass bottles are delivered mixed. Paper is marketed elsewhere and is not on the transfer trailers.
3. Waste Management operates a transfer station in Camp Hill (the Borough of Camp Hill's materials do not go through the transfer station). Materials include newspaper, residential mixed paper, PET and HDPE plastic bottles, three colors of glass, aluminum cans, and steel cans.
4. Recycle America Alliance's Palmyra Transfer Station.

The following processing takes place at the facility:

- **Tip Floor:** All incoming material, whether single-stream, dual stream, or segregated, is tipped on a central tip floor, and pushed into a central infeed conveyor;
- **Initial Automated Sort:** The facility employs a series of automated devices for separating the fiber from the commingled containers. The specific configuration of screening and processing equipment is confidential. However, after the initial screening process, all fibers are directed to one area of the facility where they undergo additional processing, and all commingled containers are directed to another area of the facility for sorting. Contaminants are removed during the infeed process are directed to a residue container.
- **Final Sorting:** Additional sorting and contaminant removal is performed on the fiber and container lines. Manual sorting labor can be added or removed depending on the desired material quality. Contaminants and residues are ejected at several points throughout the process;
- **Baling:** The facility includes several balers. Depending on the processing line, several methods are used to get the materials from the storage container to the baler.

On the fiber side of the facility, both ONP and OCC are negatively sorted, and proceed directly to the baler after removal of contaminants. Details of the commingled container side are provided below.

- Containers are mechanically separated from paper by a star screen;
- Glass is separated from the mixed containers by a tilted shaker screen;

- All three colors of glass travel directly to a single glass bunker. The three color mix is shipped to a separate Recycle America Alliance glass processing facility for further processing;
- Aluminum cans are separated next on the conveyor by an eddy current machine. They are stored in a bin until ready for baling;
- An overhead magnet removes ferrous metals and deposits them in a container; and
- The remaining plastics (bottles and jugs) are not sorted and include four basic types: PET, HDPE natural, HDPE pigmented, and 3-7 plastic containers. The plastic bottles are dropped into a specialized cage for storage until baling and shipment to the Recycle America Alliance PREI facility in North Carolina for further processing.

Table H-2 summarizes the materials recovered at the facility.

Table H-2
Recovered Materials Summary

Material Type	Average Monthly Quantity (Tons)	Percentage Composition
Fiber		
OCC	443.65	9.4%
ONP #8	1,853.32	39.2%
Flexo ONP	227.32	4.8%
Subtotal	2,524.29	53.4%
Containers		
Plastic Mix 1-7	374.55	7.9%
Clear Glass	40.81	0.9%
3 Mix Glass	1,074.89	22.7%
Aluminum	51.36	1.1%
Bi-metal	214.82	4.5%
Subtotal	1,756.42	37.1%
Contaminants/Residues	449.64	9.5%
Grand Total	4,730.36	100%

Note: based on November 2003 to January 2004 average data

H.2 Sampling Summary

Sampling was performed over two separate periods. The first sampling period was a four-day sampling and sorting event in October 2002, which was less than a year after the facility was retrofitted as a single stream MRF. As the first single stream processing facility in Pennsylvania, the facility was still in the early stages of sourcing single stream material and was still adapting internal processing configurations. Additionally, the community recycling programs that feed into this MRF were also in the process of converting to single stream systems, and may not have been representative of a mature single stream program. For these reasons a second round of sorts at the MRF were warranted and were conducted from March 22 – 26, 2004.

The objective of the sampling event was to investigate the composition of materials as they are received and processed by the MRF. Three specific material streams were included in the sampling and sorting activities:

- Incoming materials from both residential and commercial generators;
- Processed (recovered) materials such as mixed plastics, and newspaper; and
- Residues and contaminants that were ejected from various points along processing lines at the facility.

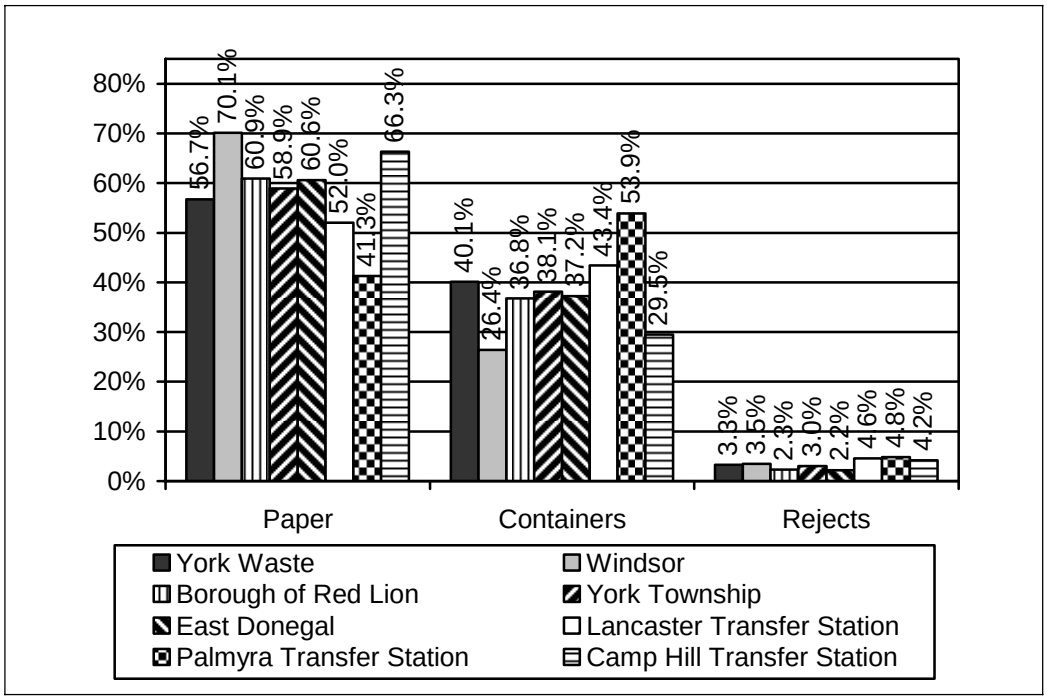
Material samples were taken from each of these three streams using a variety of techniques designed to assure that the samples would be representative. Incoming material samples were taken by sorting a representative "scoop" of material. Processed material samples were either taken from broken bales, from the end of conveyor belts, or from material storage containers in the MRF. Residues and contaminants were taken similarly from appropriate ejection points in the facility. Sample sizes were targeted for 250 to 300 pounds.

This study intended to obtain samples primarily from incoming materials, with several samples reserved for processed materials and rejects and residues. This sampling plan was selected to provide the best statistical confidence on data from incoming material.

H.3 Composition of Incoming Materials

Figure H-1 summarizes the relative composition of paper, containers, and rejects in incoming residential recycling program materials that were received at the MRF.

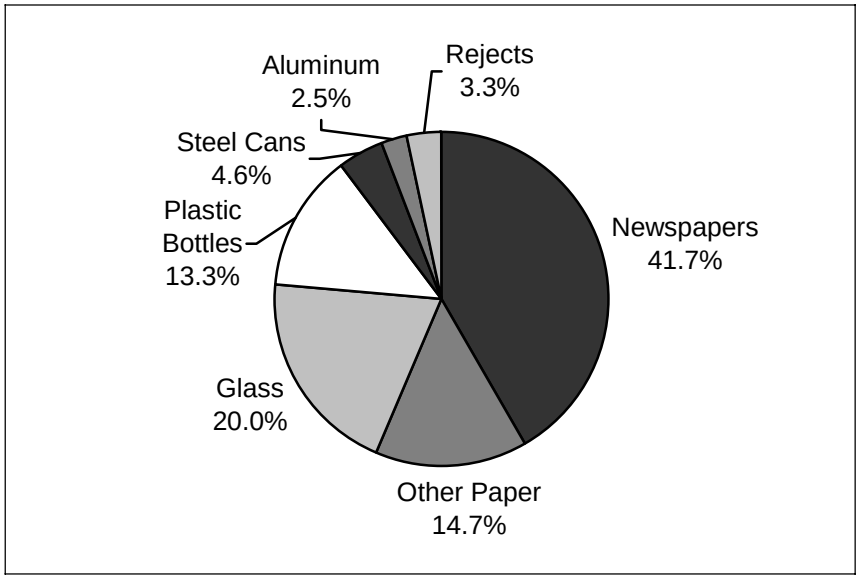
Figure H-1
Composition of Incoming Materials



The Lancaster, Palmyra, and Camp Hill transfer station compositions that are shown in Figure H-1 are derived from numerous samples (seventeen in total), all taken during the second sampling event.[5] It should be noted that three samples were also taken from the Harrisburg Transfer Station, averaging 28 percent paper, 68 percent containers, and 4 percent contaminants. The Harrisburg data was not included in Figure H-1 because it was apparent that Harrisburg's past history of not including newspapers in its curbside collection resulted in Harrisburg data not being representative of other collection programs.

The York Waste, Inc. composition that is listed in Figure H-1 is actually a composite of six different samples taken from that hauler's loads as specific information concerning the community of origin of York Waste's loads was not available. Figure H-2 shows additional detail on the composition of York Waste's incoming material.

Figure H-2
Composition of York Waste Incoming Single Stream Residential Recyclables



Note: composition based on average of six individual samples.

Figures H-3 through H-5 show the incoming composition of single stream recyclables from East Donegal, Windsor, and York Townships, respectively.

[5] A total of six samples were taken from Camp Hill, Lancaster, and Harrisburg transfer loads during the first sampling event. However, it was determined that those data were not usable because of the extreme variation that was noted between individual samples. At the time of the first sort it is believed that fibers and commingled containers were collected in two-stream manner from communities served by those transfer stations and then partially mixed together at transfer stations for delivery to the MRF. The mixing that occurred was not sufficient to provide representative samples, nor did the original sampling plan provide for taking numerous samples to overcome variation. Less sample-to-sample variation was observed during the second round of sorts, plus more samples were taken so as to provide usable data.

Figure H-3
Composition of East Donegal
Incoming Single Stream Residential Recyclables

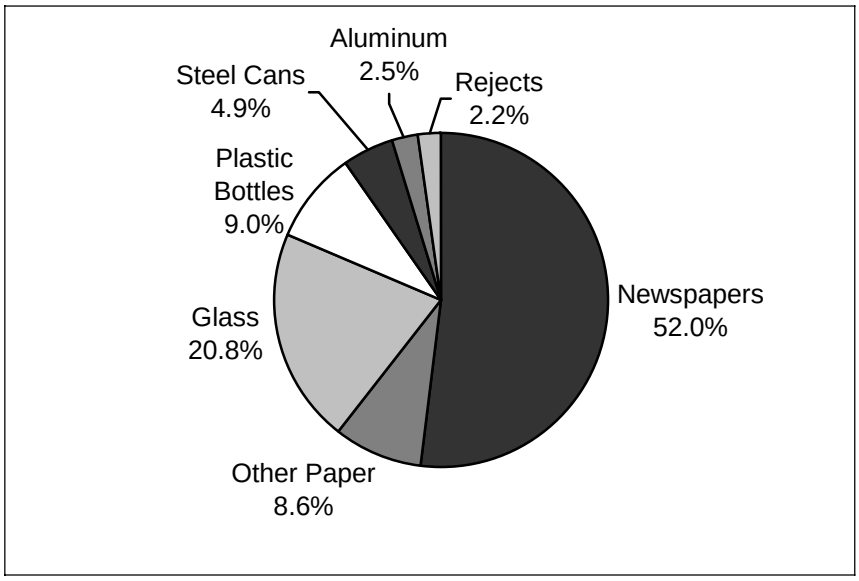


Figure H-4
Composition of Windsor
Incoming Single Stream Residential Recyclables

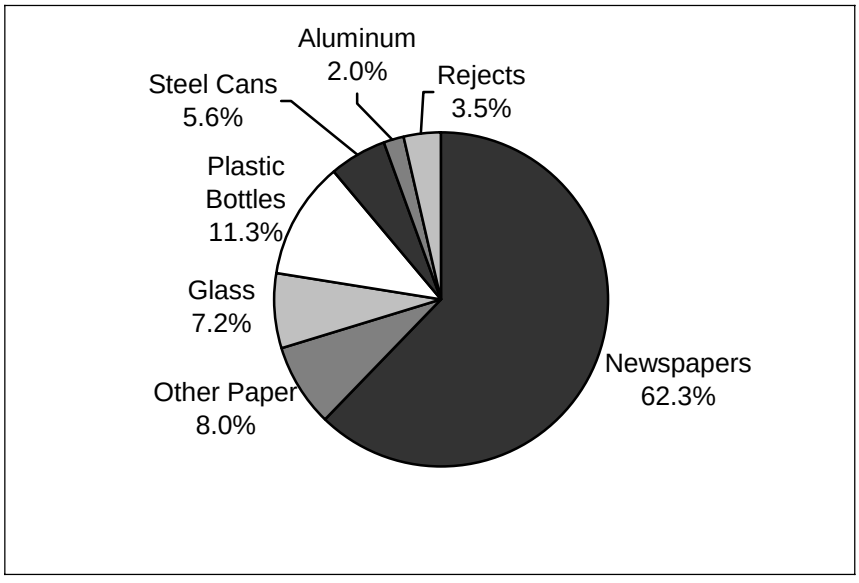


Figure H-5
Composition of York Township
Incoming Single Stream Residential Recyclables

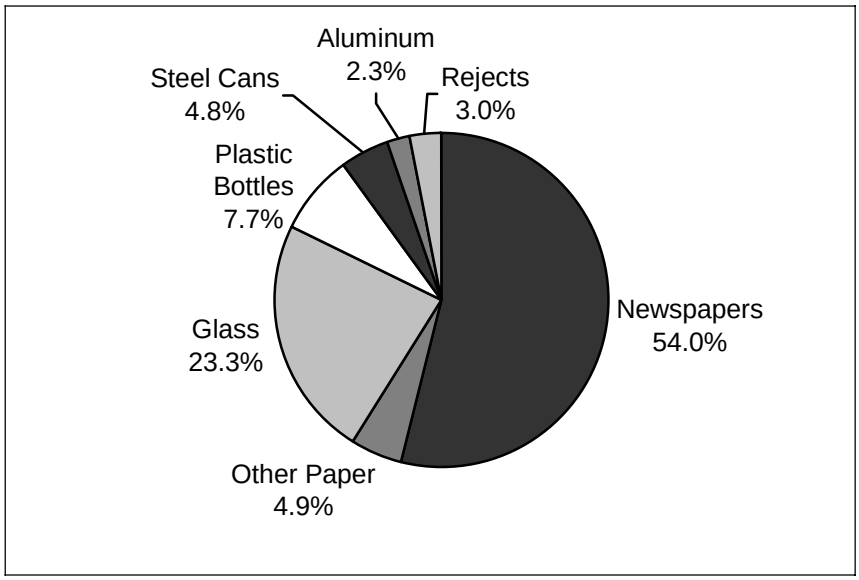
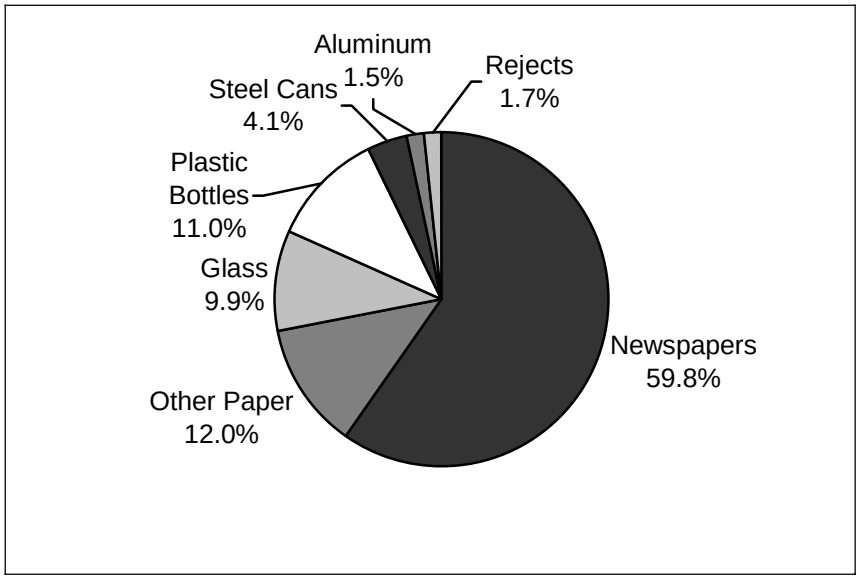


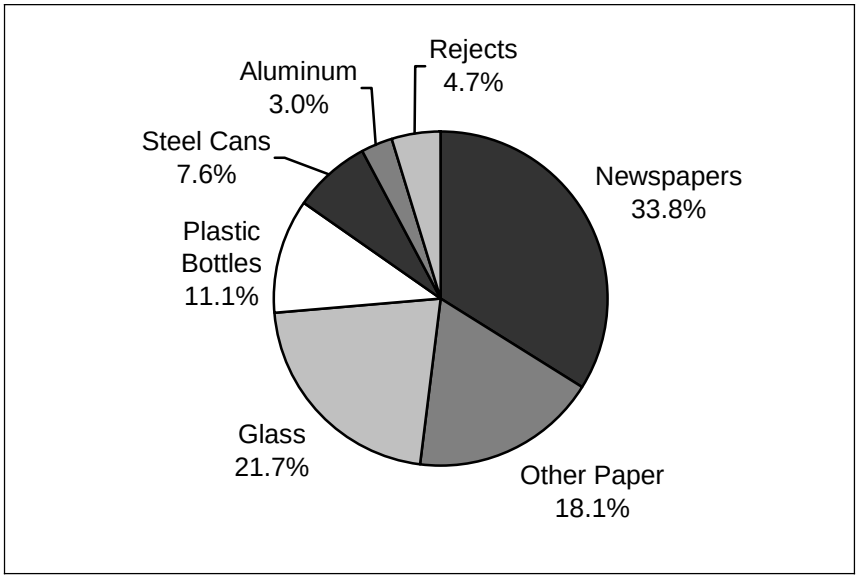
Figure H-6 shows the incoming composition of residential recyclables that were collected in a two-stream manner in the Borough of Red Lion.

Figure H-6
Composition of Borough of Red Lion
Incoming Two-Stream Residential Recyclables



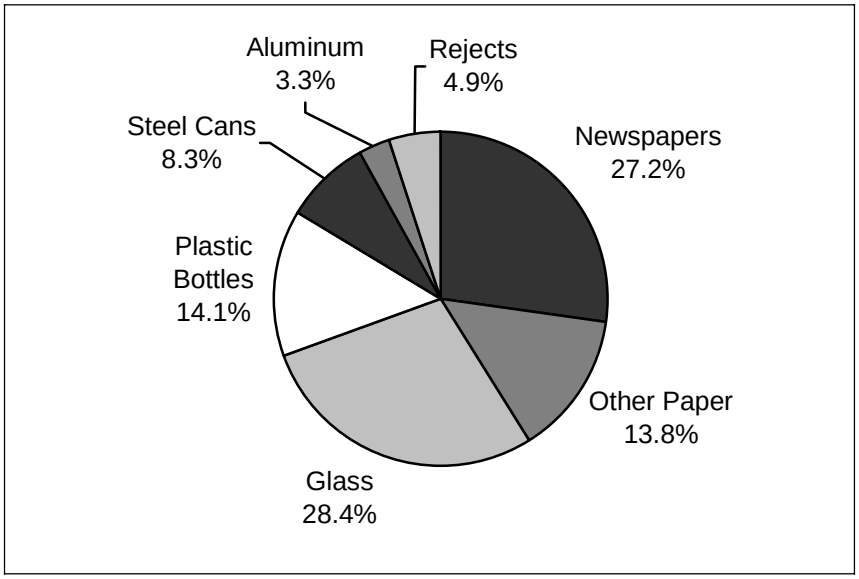
Figures H-7 and H-8 show the composition of residential recyclables delivered by transfer trailers from the Lancaster Transfer Station and the Palmyra Transfer Station.

Figure H-7
Composition of Lancaster Transfer Station
Incoming Single Stream Residential Recyclables



Note: composition based on average of six individual samples

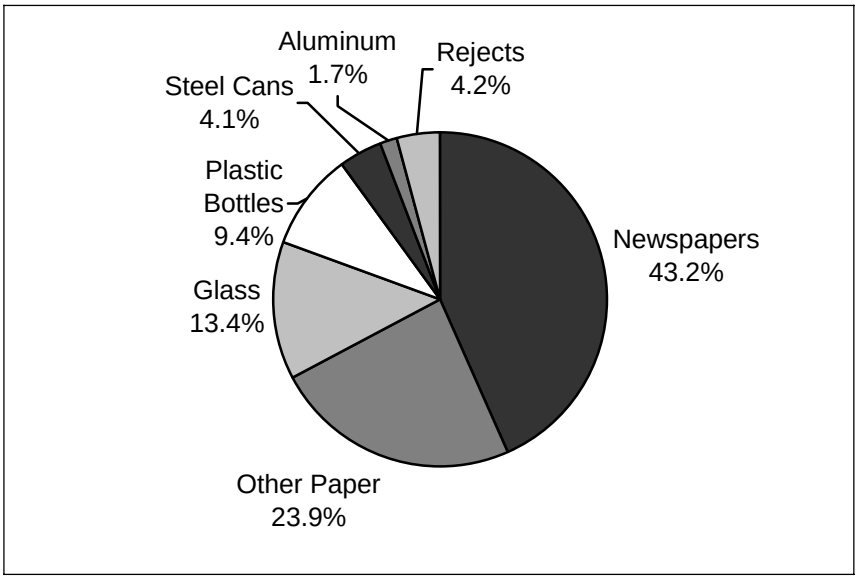
Figure H-8
Composition of Palmyra Transfer Station
Incoming Single Stream Residential Recyclables



Note: composition based on average of four individual samples

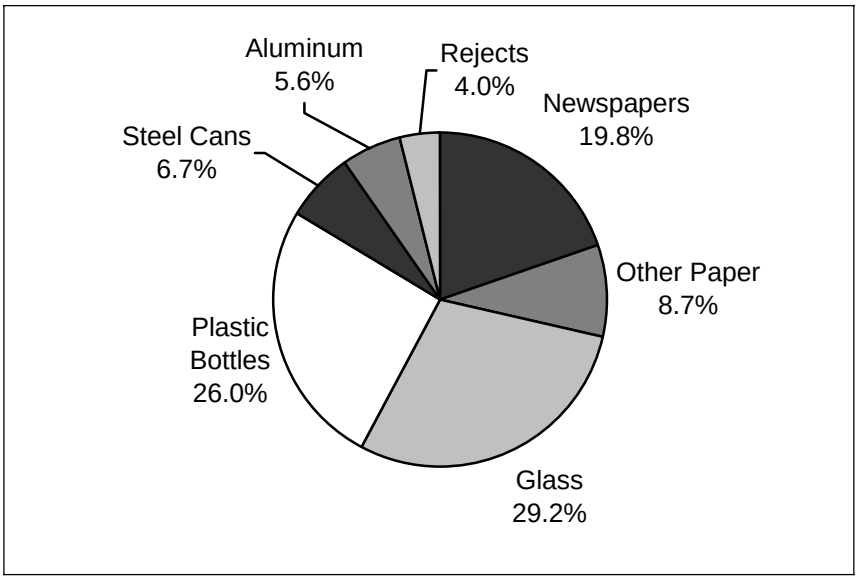
Figures H-9 and H-10 show the composition of residential recyclables delivered by transfer trailers from the Camp Hill Transfer Station and the Harrisburg Transfer Station.

Figure H-9
Composition of Camp Hill Transfer Station
Incoming Single Stream Residential Recyclables



Note: composition based on average of seven individual samples

Figure H-10
Composition of Harrisburg Transfer Station
Incoming Single Stream Residential Recyclables



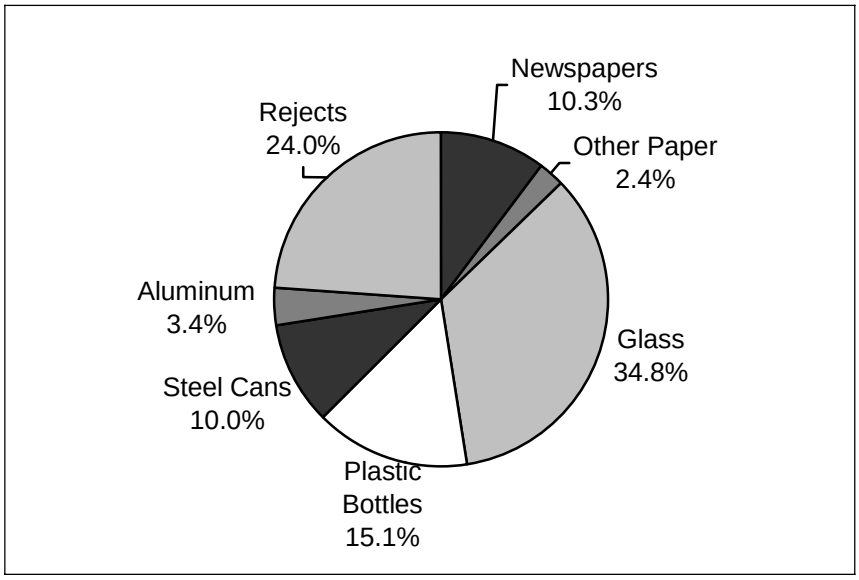
Note: composition based on average of three individual samples

As Figure H-10 shows, only a small percentage of residential recyclables from Harrisburg were newspapers when compared to all other incoming residential

programs. This is believed to be due to Harrisburg's past history of not including newspapers in its curbside collection program.

Figure H-11 shows the incoming composition of residential recyclables that were collected in a Lower Windsor Township drop-off. As the figure shows, 24 percent of the incoming material was found to be rejects.

Figure H-11
Composition of Lower Windsor Township Incoming Drop-Off Materials



Figures H-12 and H-13 show the composition of two samples of incoming mixed apartment and commercial recyclables.

Figure H-12
Composition of Incoming Mixed Apartment and Commercial Recyclables - Sample 1

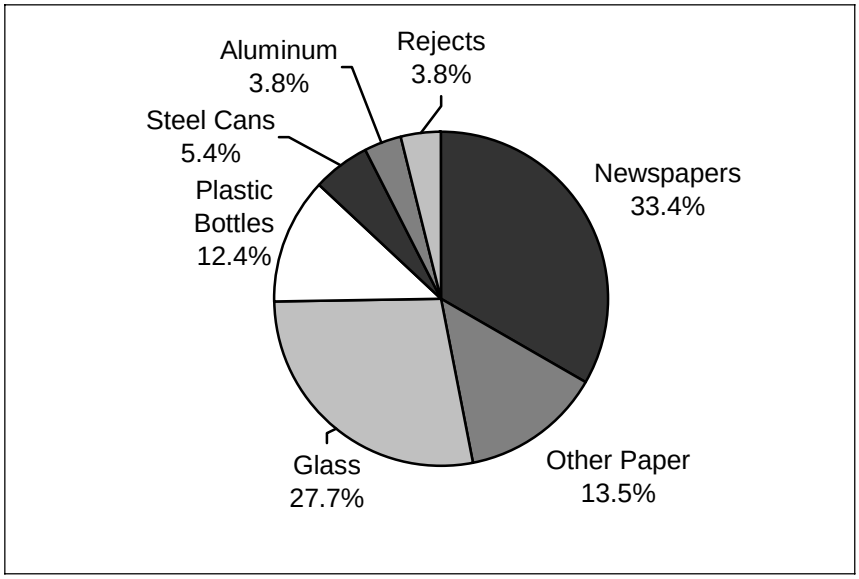
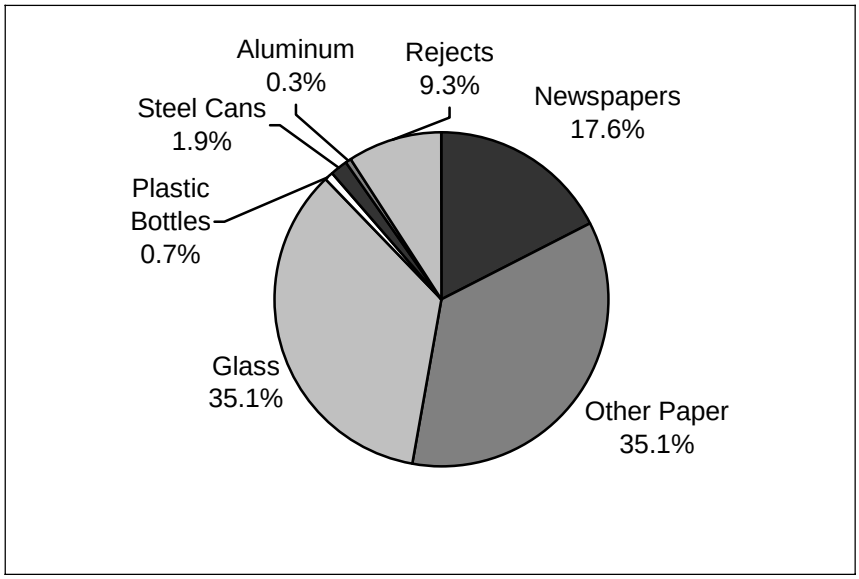


Figure H-13
Composition of Incoming Mixed Apartment and Commercial Recyclables - Sample 2



Figures H-14 and H-15 show the composition of two loads of incoming corrugated containers.

Figure H-14
Composition of Incoming Commercial Corrugated Containers — Sample 1

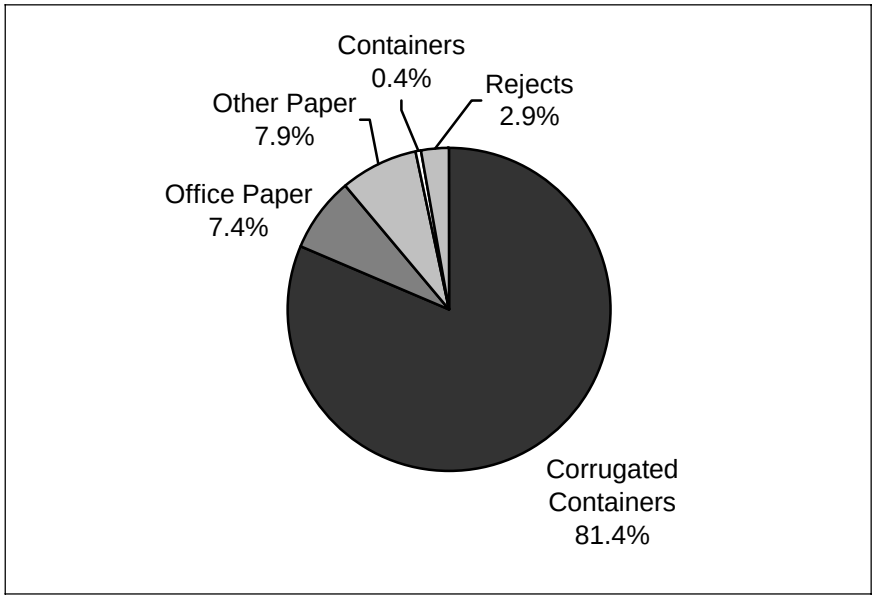
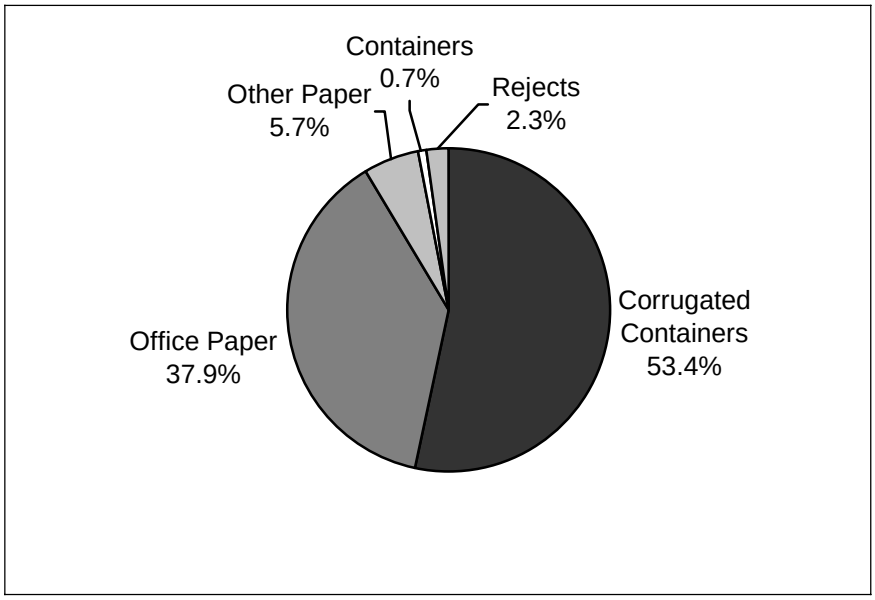


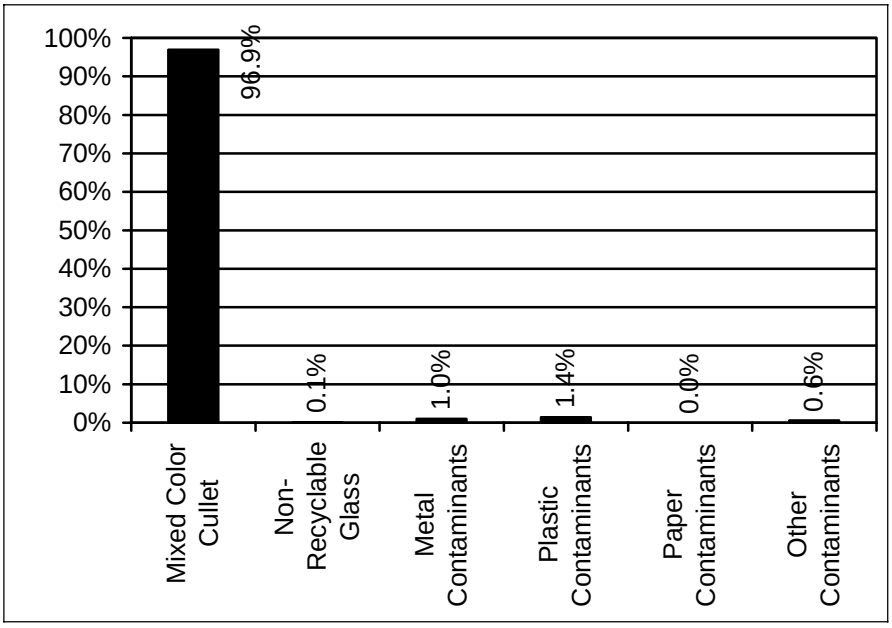
Figure H-15
Composition of Incoming Commercial Corrugated Containers — Sample 2



H.4 Composition of Processed Recyclables

Figure H-16 shows the composition of processed glass containers. These containers are not color sorted, but instead are sent to a specialized Recycle America (Container Recycling Alliance) plant for additional sorting and processing.

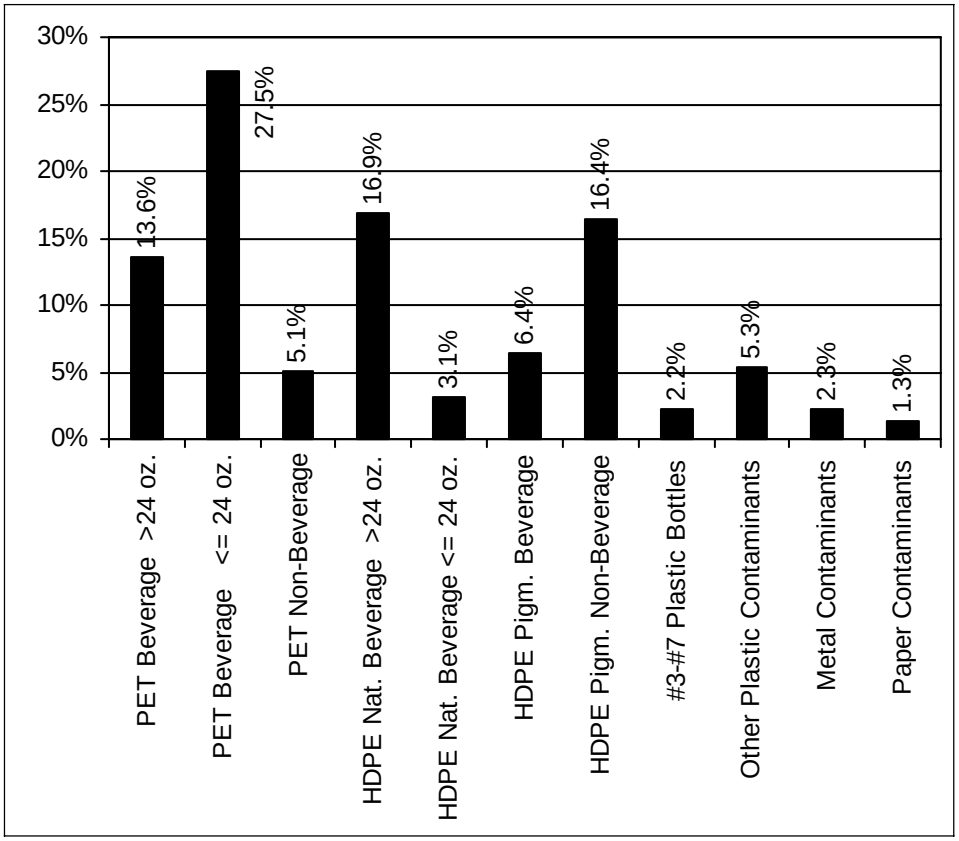
Figure H-16
Composition of Processed Glass Containers



Other Contaminants shown in Figure H-16 are organic and inorganic materials.

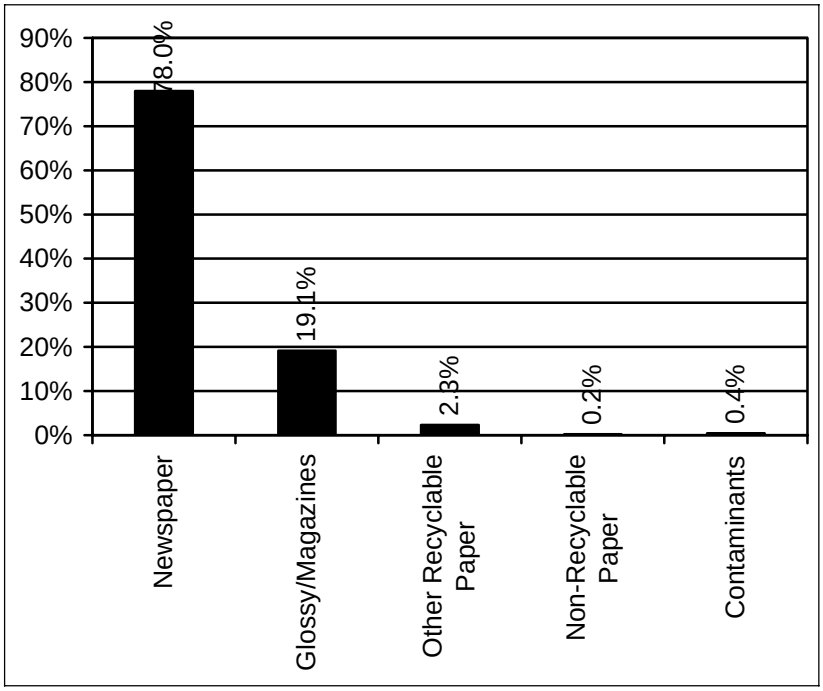
Recycle America also does not sort plastic bottles by resin type at the York MRF. Instead they are baled as mixed plastic bottles and sent to Recycle America's automated sorting facility in North Carolina. Figure H-17 shows the composition of processed plastic bottles.

Figure H-17
Composition of Processed Plastic Bottles



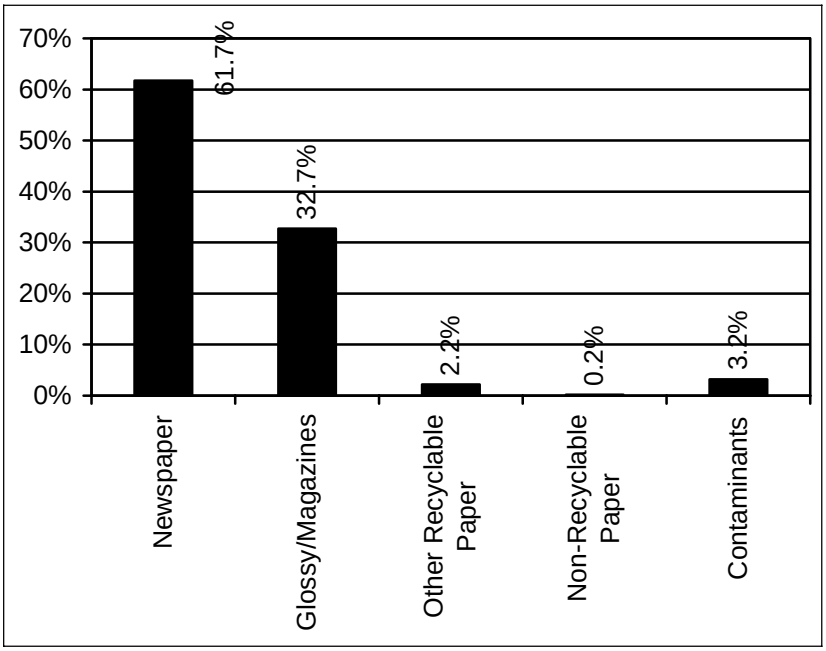
On the paper side of the facility, both ONP and OCC are negatively sorted, and proceed directly to the baler after removal of contaminants. Figures H-18 and H-19 show the composition of two samples of processed residential newspaper.

Figure H-18
Composition of Processed Newspaper - Sample 1



Contaminants shown in Figure H-18 are PET bottles and aluminum cans.

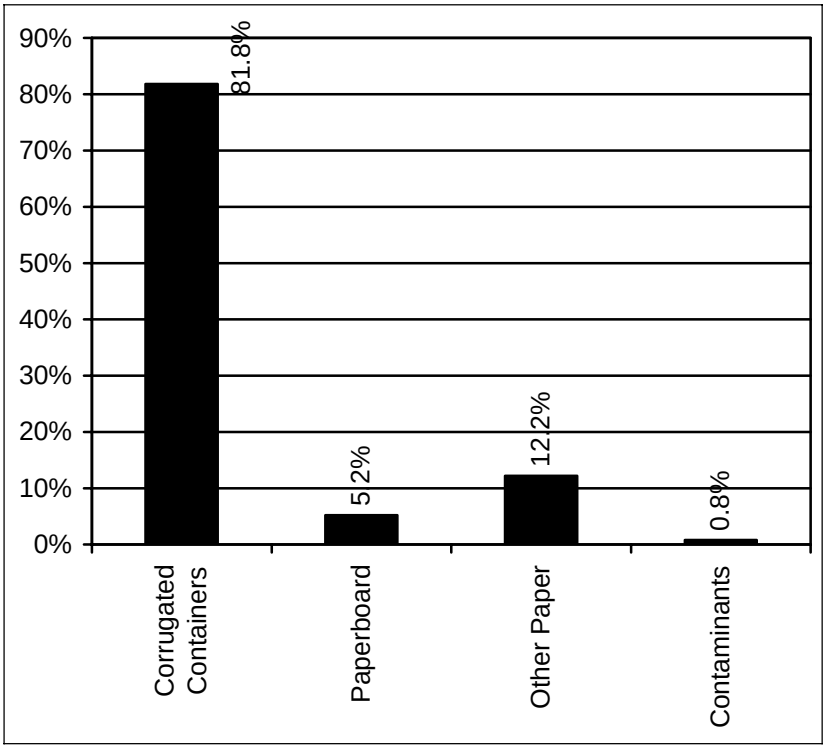
Figure H-19
Composition of Processed Newspaper - Sample 2



Contaminants shown in Figure H-19 are an assortment of PET and HDPE bottles, aluminum cans, steel cans, film bags, organics, and non-container rigid plastics.

Figure H-20 shows the composition of processed corrugated containers.

Figure H-20
Composition of Processed Corrugated Containers



Contaminants shown in Figure H-20 are steel cans and plastic bottles.

H.5 Composition of Rejects and Residues

Rejects and residues produced by the MRF averaged 16.8 percent of materials received over the period from June to September 2002. The MRF subsequently worked to reduce rejects and residues and from November 2003 to January 2004 rejects and residues averaged 9.5 percent. Detailed information about the processing system and reject/residue ejection points was not available. However, samples were obtained from several different points of the process. Figures H-21 through H-23 show the composition of three reject and residue samples that were taken during the first period of sorting, and Figures H-24 and H-25 show the composition of two reject and residue samples that were taken during the second period of sorting.

Figure H-21
Composition of Paper Sort Line Rejects/Residues – Sample 1

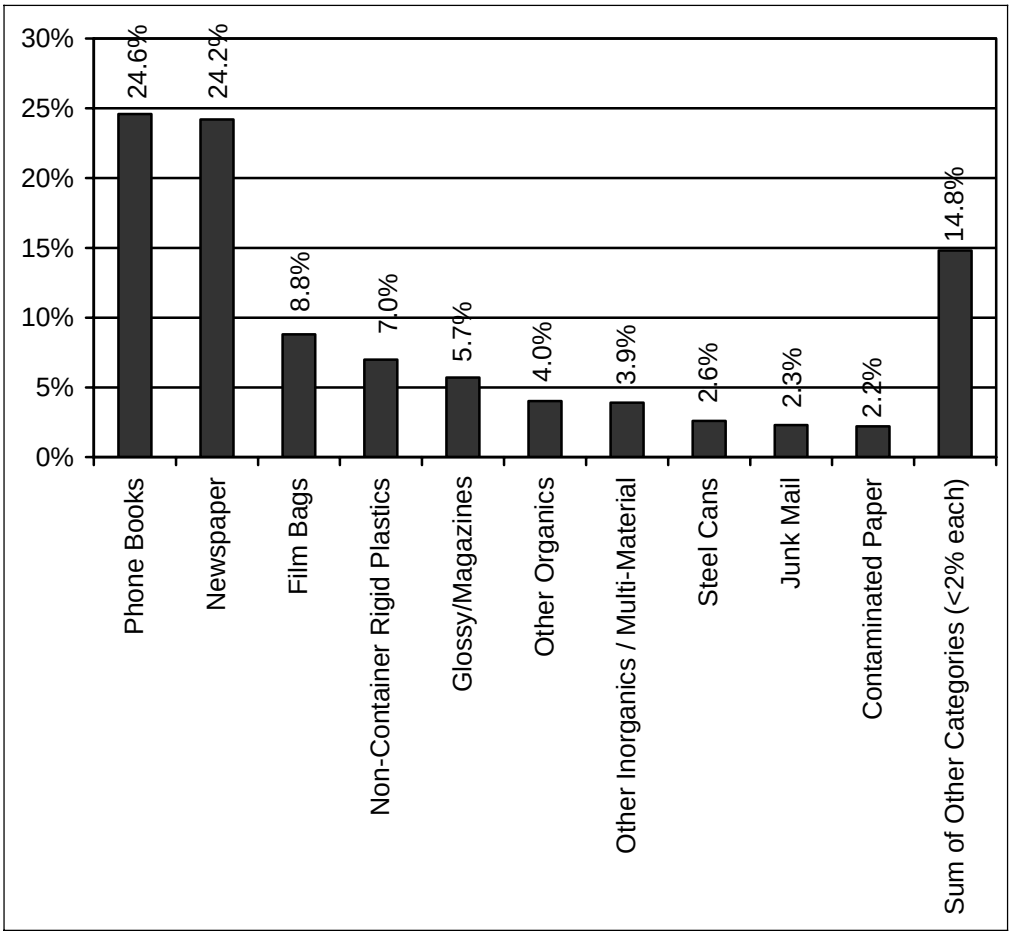


Figure H-22
Composition of Paper Sort Line Rejects/Residues – Sample 2

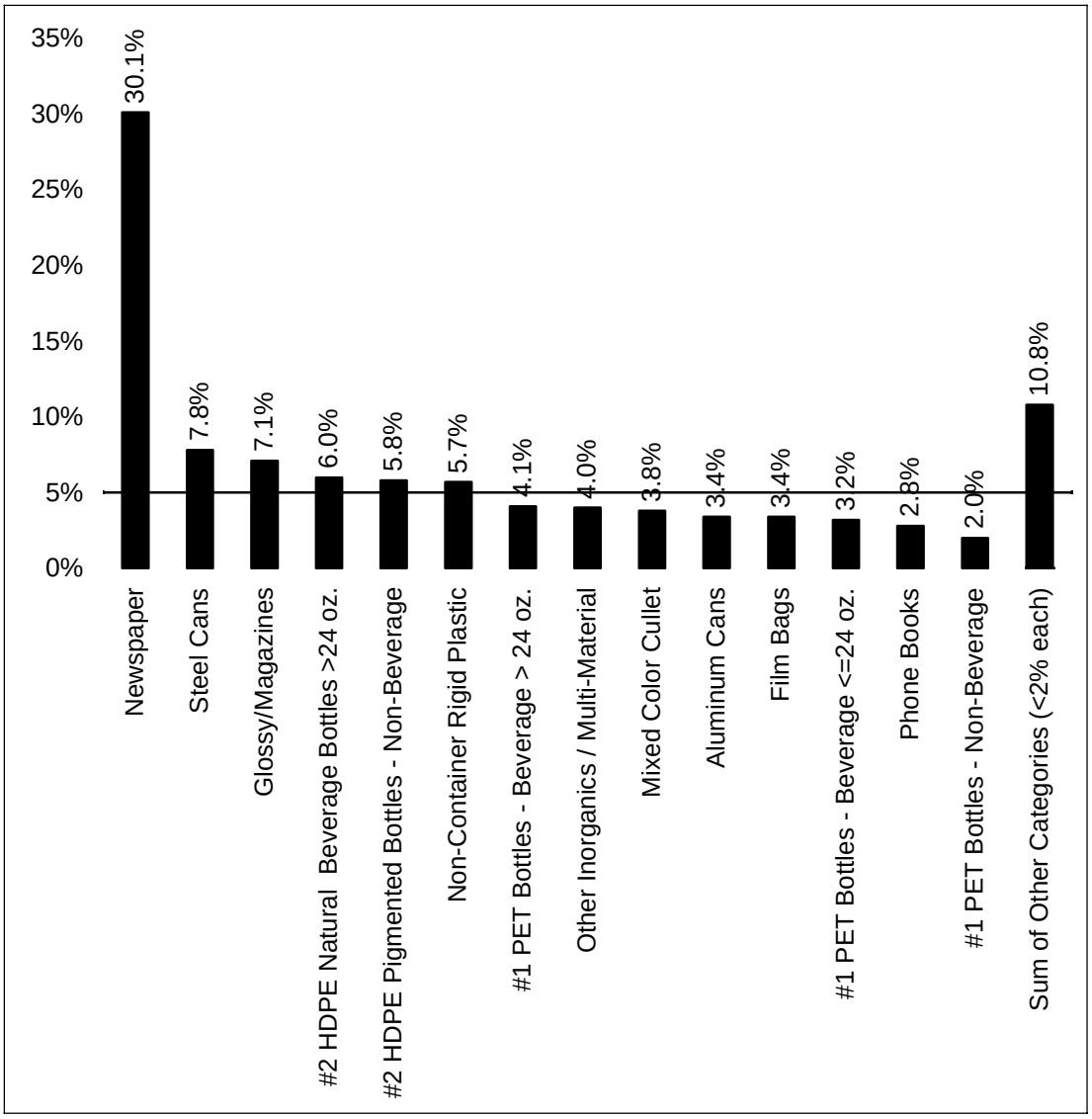


Figure H-23
Composition of Sort Line Rejects/Residues – Sample 3

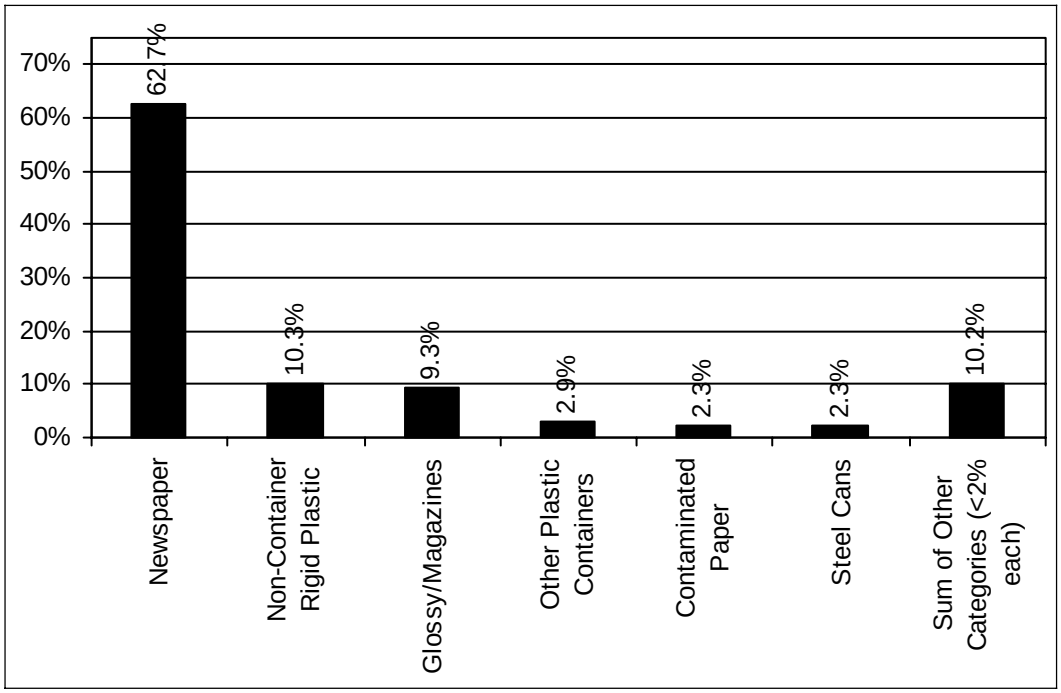


Figure H-24
Composition of Sort Line Rejects/Residues – Sample 4

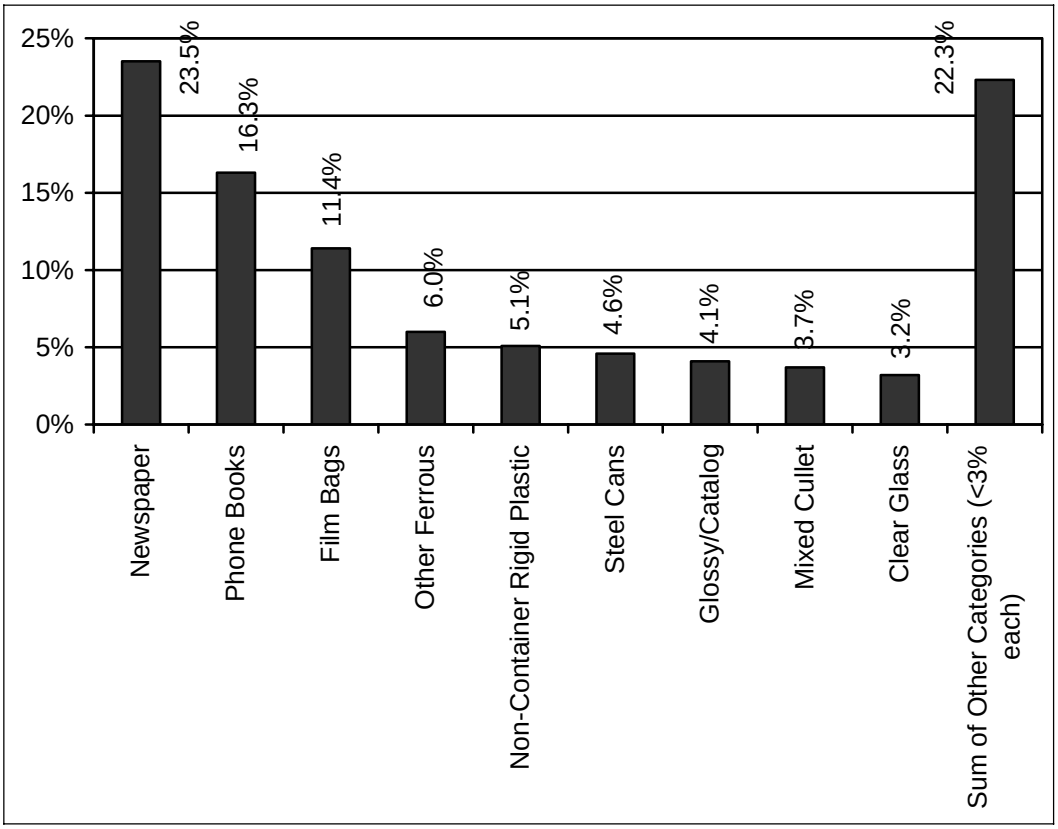
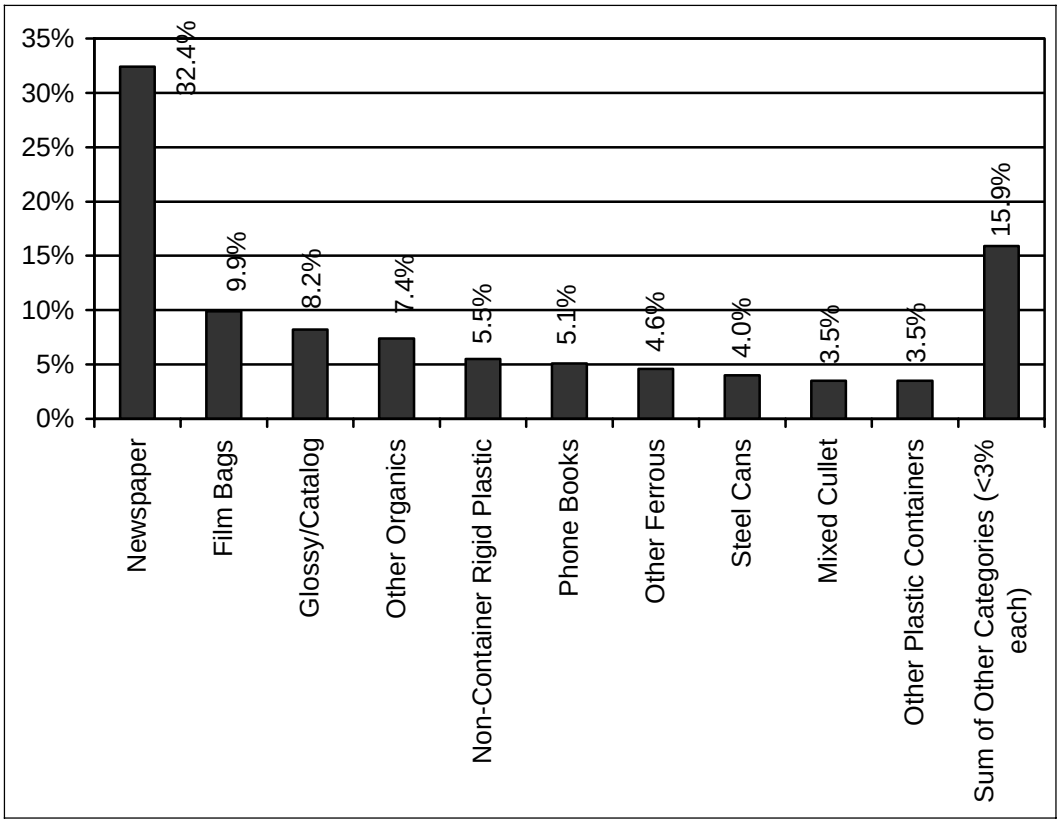


Figure H-25
Composition of Sort Line Rejects/Residues – Sample 5



As Figures H-21 through H-25 show, newspaper was the most predominant material found in the MRF's residue.

Appendix I
WORLD RESOURCE RECOVERY SYSTEMS MRF

I.1 Collection and Processing Overview

The World Resource Recovery Systems Inc. recycling facility processes dual stream residential recyclables and commercial paper (primarily OCC) from a range of sources. Much of the residential materials processed by the recycling facility come from the City of Erie's residential program. Residential recyclables from other surrounding municipalities are also processed at World Resource's facility. World Resource Inc. considers its processing operation and records to be confidential and information on source and processing totals were therefore not available for this study.

The City of Erie's residential collection program collects recyclables during the night on the same night as refuse collection. The material collected alternates on a weekly basis, with containers one week and fiber the following week. Containers that are accepted include aluminum and steel cans, glass containers, and #1 and #2 plastic containers — these containers must be set out in blue bags. Fiber includes:

- Newspapers, which must be bundled;
- Magazines, which must be bundled;
- Cardboard, cereal and food boxes, soft drink and beer cartons, paper milk and egg cartons and paper bags, which must be bundled; and
- Envelopes and writing, typing, wrapping and computer paper, including all junk mail — these items are to be set out in clear plastic bags.

I.2 Sampling Summary

A four-day sampling and sorting event was conducted at World Resource Recovery Systems, Inc. from April 27-30, 2004. The objective of the sampling event was to investigate the composition of materials as they are received and processed by the MRF. Three specific material streams were included in the sampling and sorting activities:

- Incoming materials from both residential and commercial generators;
- Processed (recovered) materials, such as OCC and newspaper; and
- Residues and contaminants that were ejected from various points along processing lines at the facility.

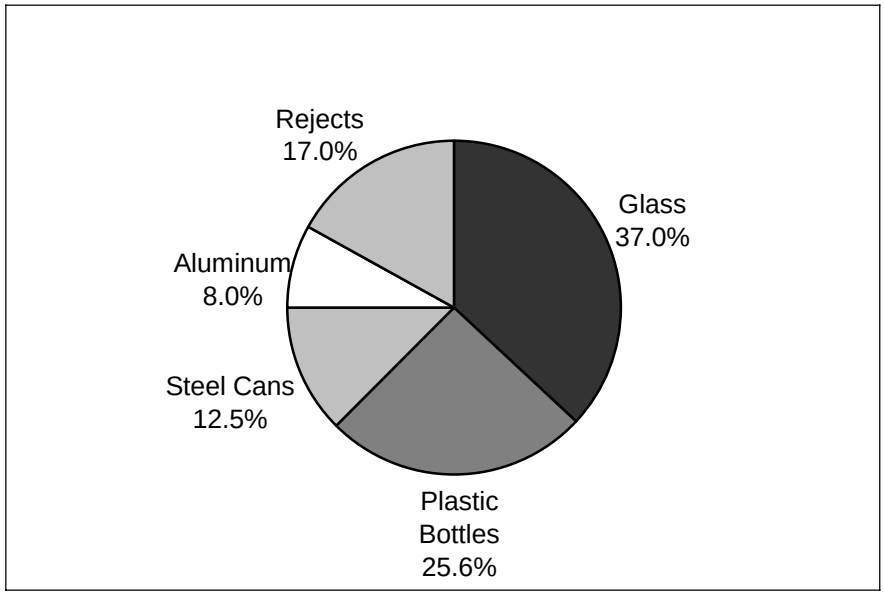
Material samples were taken from each of these three streams using techniques designed to assure that the samples would be representative. Incoming material samples included a representative “scoop” of material. Processed material samples were taken from bales. Residues and contaminants were taken from appropriate ejection points in the facility. Sample sizes were targeted for 250 to 300 pounds.

This study intended to obtain samples primarily from incoming materials, with several samples reserved for processed materials and rejects and residues. This sampling plan was selected to provide the best statistical confidence on data from incoming material.

I.3 Composition of Incoming Materials

Figure I-1 shows the composition of incoming Erie residential containers. Because of Erie's alternating paper-containers collection schedule, incoming paper from Erie was not available for characterization during the period of this sort.

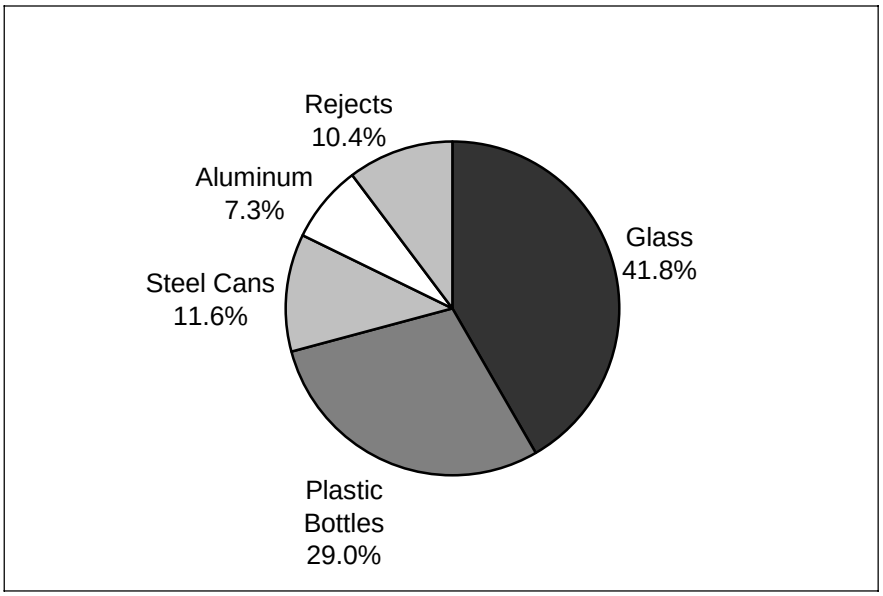
Figure I-1
Composition of Incoming Erie Curbside Collected Containers



Note: composition based on average of thirteen individual samples

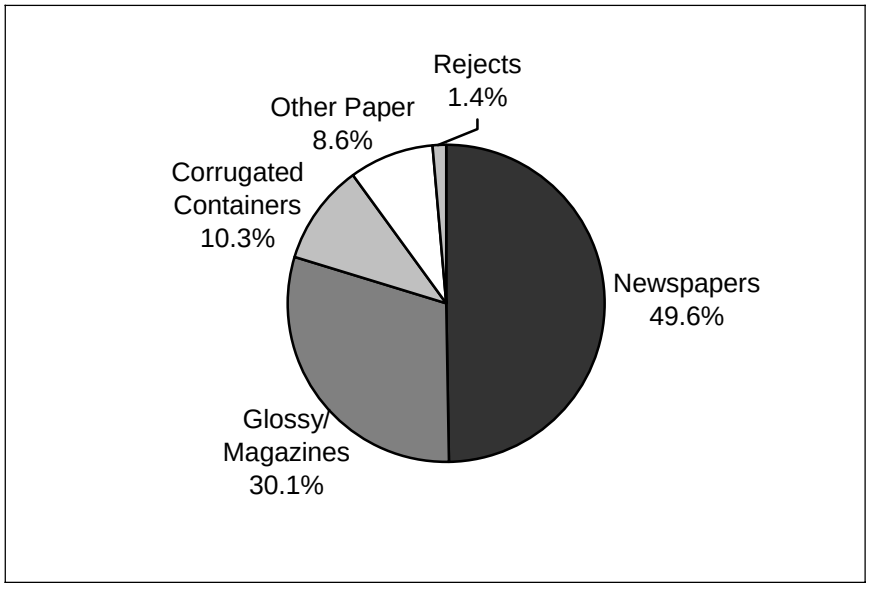
Figures I-2 and I-3 show the composition of incoming containers and paper from other municipalities in Erie County that were collected by a private hauler.

Figure I-2
Composition of Incoming Curbside Collected Containers



Note: composition based on average of six individual samples

Figure I-3
Composition of Incoming Curbside-Collected Residential Paper

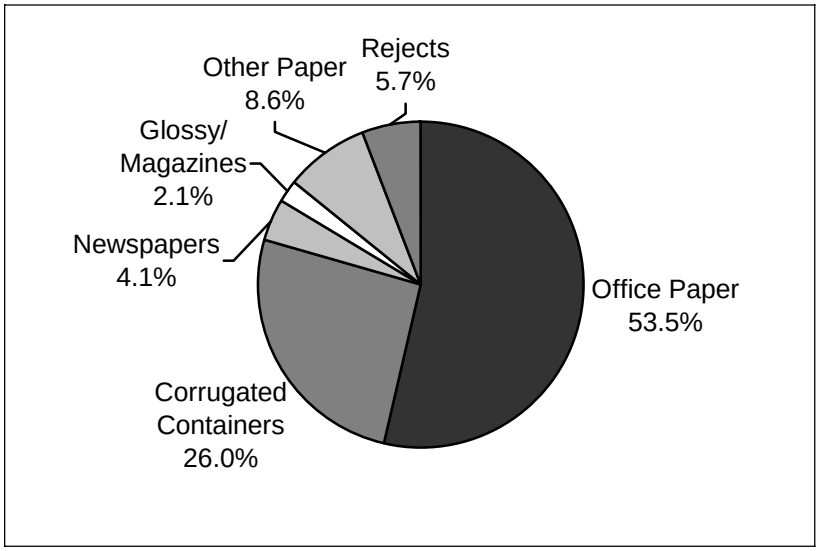


Note: composition based on average of five individual samples

As Figure I-3 shows, incoming paper from municipalities in Erie County contained a significant amount of corrugated containers and other paper as a result of accepting a broad variety of paper in those collection programs.

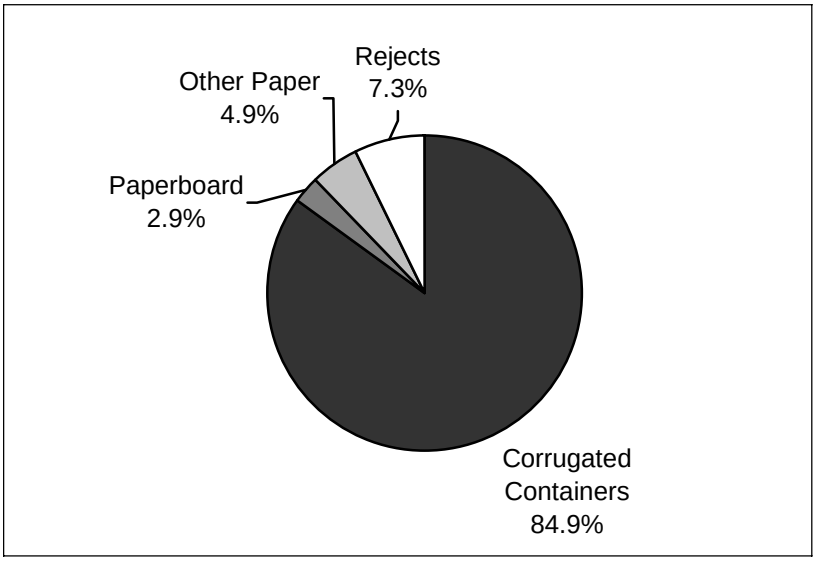
Figures I-4 and I-5 show the composition of incoming commercial office paper and incoming commercial corrugated containers.

Figure I-4
Composition of Incoming Commercial Office Paper



Note: composition based on average of two individual samples

Figure I-5
Composition of Incoming Corrugated Containers

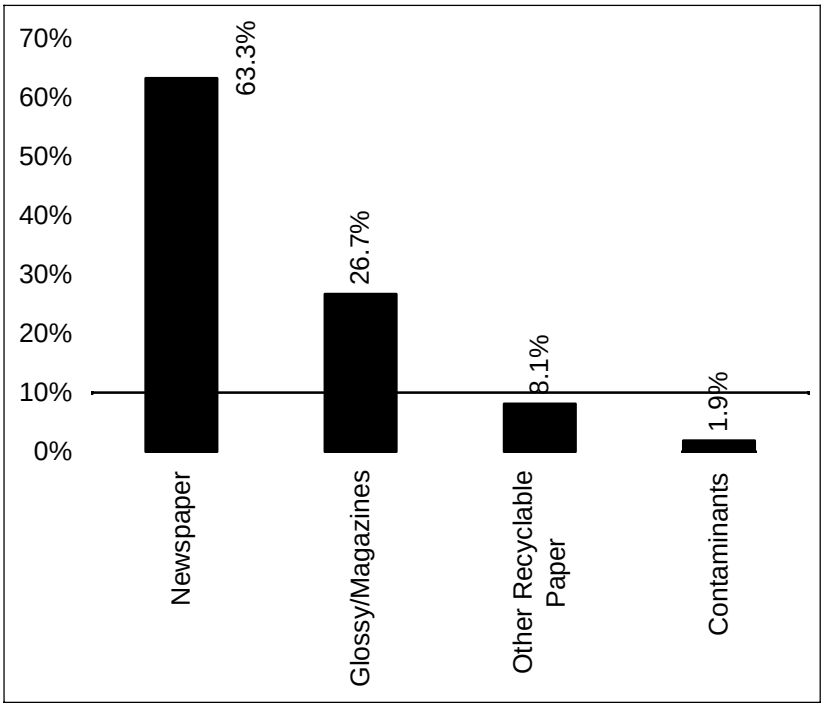


Note: composition based on average of four individual samples

I.4 Composition of Processed Recyclables

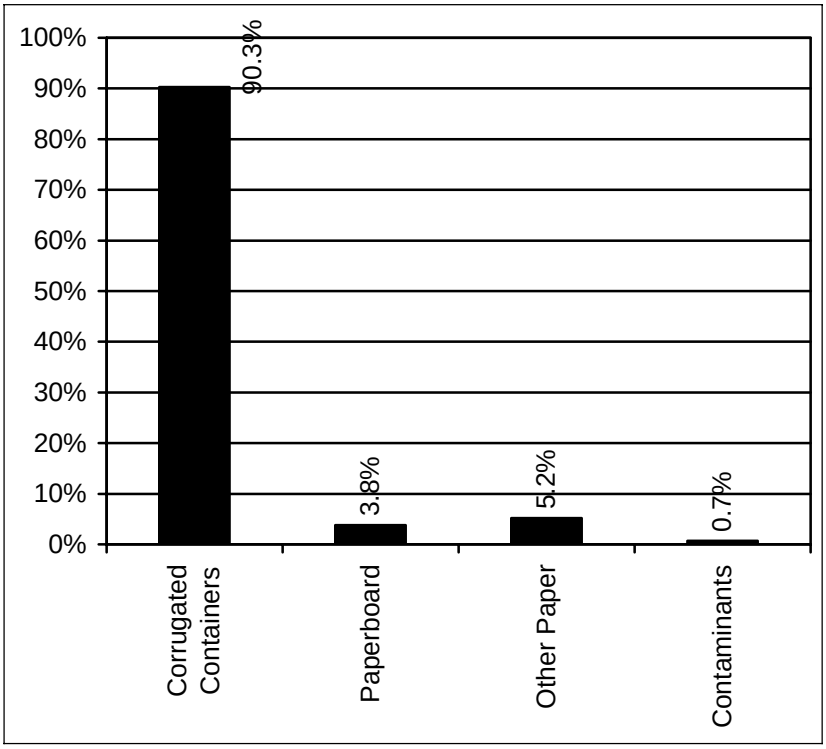
Figure I-6 and I-7 show the composition of processed newspaper and corrugated containers respectively.

Figure I-6
Composition of Processed Newspaper



Contaminants shown in Figure I-6 are aluminum and steel cans, #3-#7 plastic bottles, non-bottle plastics, and organic and inorganic materials.

Figure I-7
Composition of Processed Corrugated Containers

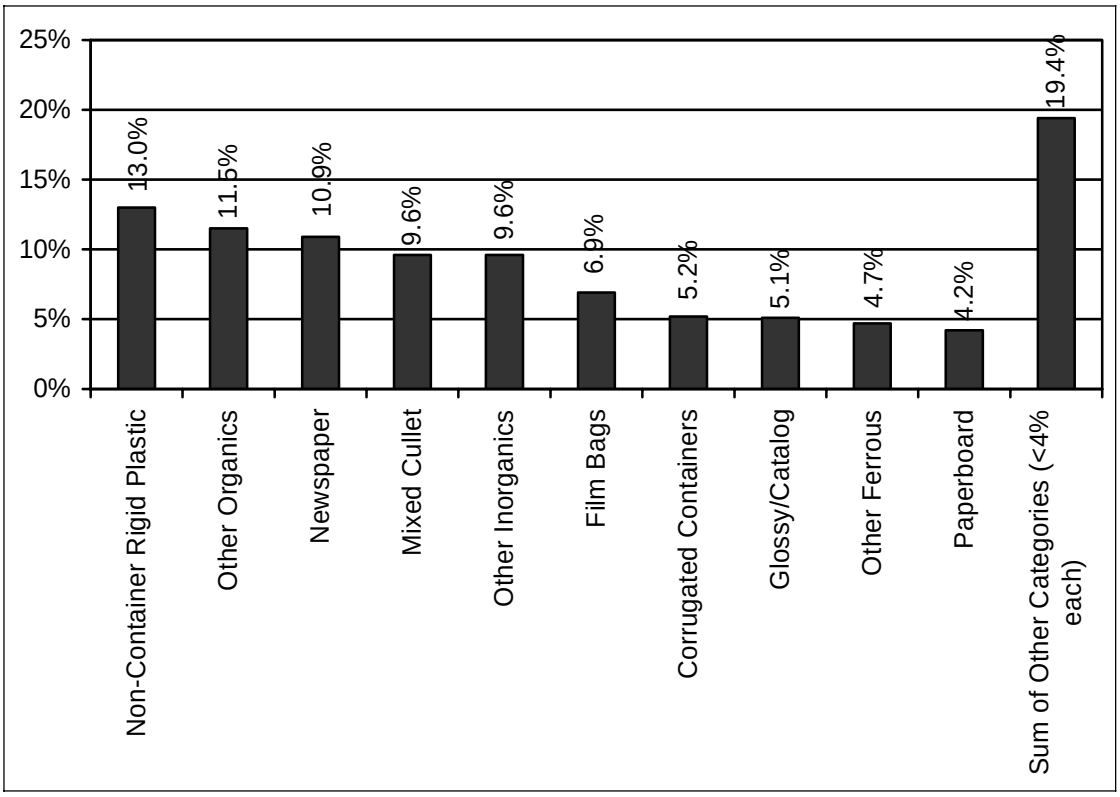


Contaminants shown in Figure I-7 are steel cans, non-container rigid plastics, and film bags.

I.5 Composition of Rejects and Residues

Incoming paper streams of newspapers, OCC, and office paper are negatively sorted at this facility and recyclable paper that does not conform to the grade being processed and all rejects from paper processing are picked off the processing line and dropped into bunkers located below the line. The composition of paper processing rejects is shown in Figure I-8.

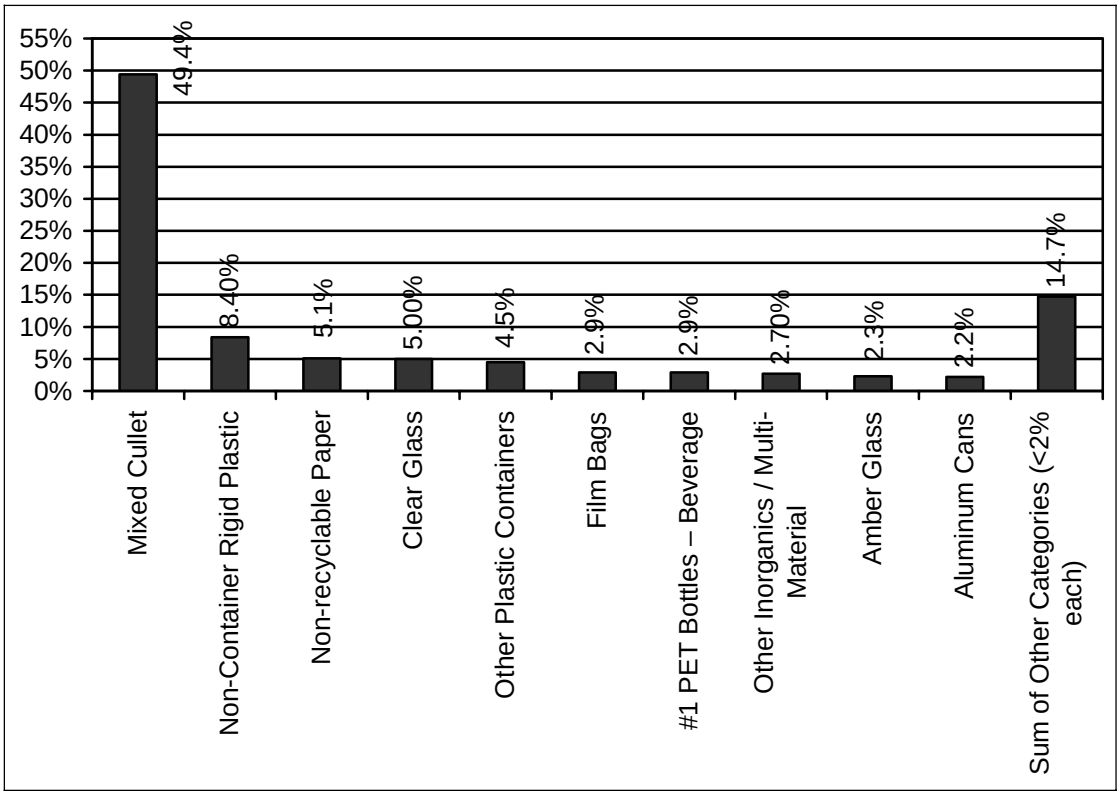
Figure I-8
Composition of Rejects from Paper Sort Line



Note: composition based on average of two individual samples

Incoming containers are positively sorted and any residue that remains on the processing line becomes residue. Figure I-9 shows the composition of the residue that is discharged from the end of the containers processing line.

Figure I-9
Composition of Residue from Containers Sort Line



Note: composition based on average of two individual samples

As Figure I-9 shows, mixed color cullet composes half of the containers processing residue.