FINAL REPORT

VERMONT WASTE COMPOSITION STUDY

June 2002

Prepared for:
Vermont Department of Environmental Conservation
Solid Waste Program

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ACKNOWLEDGEMENTS

DSM Environmental Services, Inc. (DSM) relied on the good will and logistical support of Casella Waste Management at the Waste USA landfill and Waste Systems International (WSI) at the Chittenden County transfer station. In both cases these companies provided, at no cost to DSM or the VT Department of Environmental Conservation (VT DEC), sorting space, front loader time to gather and deliver the samples, logistical support from the scale house to help select the loads, and, in the case of Waste USA, roll-off boxes to dump the sampled waste. Without this significant support the waste sorting could not have been carried out.

Both Casella (All Cycle hauling division) and WSI also worked with DSM and the Chittenden Solid Waste Management District to collect representative samples of pure commercial wastes by category.

VT DEC also provided significant support in the form of VT DEC personnel who sorted with DSM and the Chittenden District each day of the sampling period. It was this team effort that helped to complete the project successfully.

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EXECUTIVE SUMMARY

During the summer of 2001, DSM Environmental Services, Inc. (DSM) was contracted by the Solid Waste Program of the Vermont Department of Environmental Conservation (VT DEC) to conduct a waste composition study at the Waste USA landfill in Coventry, VT and the WSI transfer station in Burlington, VT. DSM sub-contracted with the Chittenden Solid Waste Management District (CSWMD) for assistance with logistics and sorting at the WSI Transfer Station. These two locations were chosen to represent the urban/suburban (Chittenden County) and rural (Northeast Kingdom) populations of Vermont, to identify any differences in waste composition between these two populations.

Sorting was carried out at the Waste USA landfill for five days in August (20 – 24th), and three days in November (19 – 21st) and at the WSI transfer station for five days in August (27 – 31st), and four days in November (5-8th). These sorting periods were selected to represent two seasons, with the hope of determining whether there were seasonal differences in Vermont's waste composition.

The primary objective of the sampling program was to collect data on the composition of the waste stream for use by the VT DEC to better target future waste reduction and diversion programs. As such, the categories selected for sorting were based on what can currently be recycled in Vermont as well as materials that might have potential for future diversion (such as food waste). The second objective was to search for categories of concern, such as electronics wastes and potentially hazardous wastes. Finally, VT DEC was interested in the potential for additional diversion of construction and demolition wastes.

This executive summary has been written to give readers an overview and summary of the significant amount of data collected during the study. As such, the 26 waste categories have been consolidated into a small number of summary categories which do not necessarily match the more detailed tables contained in the text. In addition, averaging the waste composition data requires summing of the pounds of material from individual samples and then calculating the percent composition of the total. These summary tables presented as a comparison of broad material category percentages can not always be compared with the more detailed tables in the body of the report by simply taking the averages of the percents in the detailed tables.

Table E.1 lists the number of samples and the average sample size (in pounds) for each generator category. Over the two sorting periods, 24,626 pounds from 91 samples were sorted. Fifty-one residential loads and 40 commercial loads were sampled, with an average sample size of 258 pounds for residential waste and 286 pounds for commercial waste.

TABLE E.1
Number of Samples and Sample Size

Generator Type	Number of Samples	Average Sample Size	Total Sample Size
Residential	(#)	(lbs.)	(lbs.)
August, Waste USA	15	295	4,437
August, WSI	15	209	3,139
November, Waste USA	9	239	2,150
November, WSI	12	287	3,445
Sub-Total	**51**	**258**	**13,171**
Commercial			
Retail	7	158	1,108
Office	6	232	1,392
Restaurants	5	328	1,640
Grocery	6	306	1,837
Motels	2	196	391
Mixed Commercial Loads	14	363	5,087
Sub-Total	**40**	**286**	**11,455**
Total	**91**	**n/a**	**24,626**

Observations On The Residential Waste Sorts

Figure E.1 and Table E.2 illustrate what is left in the Vermont residential waste stream after ten years of public and private investment in recycling and HHW collection systems and education programs. Figure E.1 breaks out material that is currently recyclable in most Vermont programs to illustrate what percent of the material remaining in the residential waste stream is still recyclable, Table E.2 summarizes the waste composition data by major categories. For this reason one cannot directly compare Figure E.1 and Table E.1. For example, the recyclable paper category in Figure E.1 does not include books and coated boxboard while the paper category in Table E.2 does.

DSM's observations include:

- While Vermont has made impressive progress in increasing recycling of materials, approximately 24 percent of the residential waste stream remains recyclable paper and bottles and cans, which are accepted by most programs in Vermont.

- As illustrated by Table E.2, although there are variations between urban/suburban and rural residential wastes, the differences are minor and probably reflect sampling variability rather than actual difference, indicating the relative homogeneity of residential generators throughout Vermont.

- There appears to be a significant difference in the organic fraction of the waste stream between seasons. However, this difference is not due to the presence of yard wastes in the summer, but rather more fresh food waste in the summer.

- Plastics are a growing part of the waste stream. Of particular significance, although they only represent 3 percent on a weight basis, is the relatively large volume of plastic films (exclusive of garbage bags) in the waste stream.

Figure E.1
Composition of Residential Waste
(% by weight)

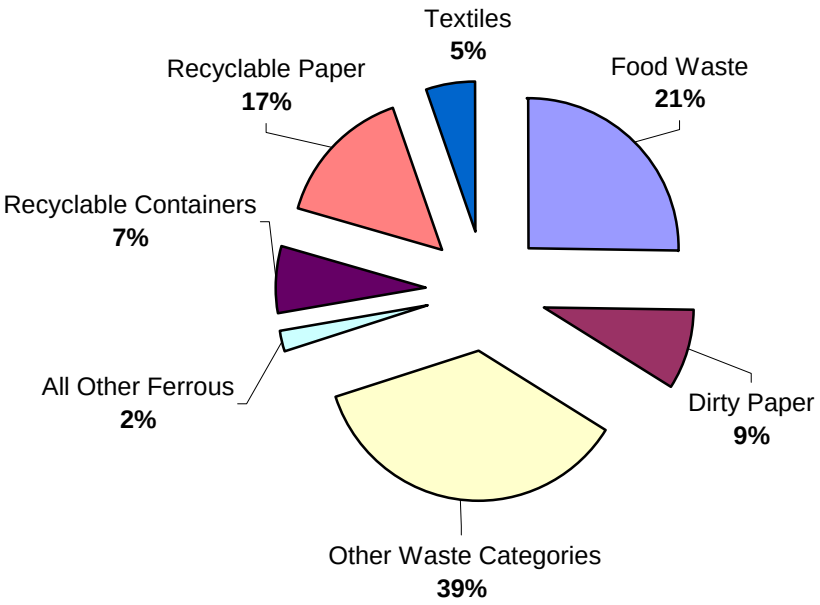


Figure E.1
Materials Included in Summary Categories

Summary Category	Categories Included
Recyclable Paper	Newspaper and inserts, Corrugated and kraft bags, Mixed paper, Magazine and coated paper, Boxboard
Recyclable Containers	Glass bottles and jars, Plastic bottles, Ferrous cans, & Aluminum cans – Deposit & non-deposit
All Other Ferrous	Brown and white goods
Food Waste	Food waste
Textiles	Textiles
Other Waste Categories	Books, Coated boxboard, Plastic clamshells, Plastic tubs, Plastic film, All other plastic, Leaf and yard waste, All other organic, Hazardous waste, Mercury containing waste, Bulky waste, Electronics and small appliances, Tires, Construction waste, All other waste

Table E.2
Comparison of Urban/Rural and Summer/Winter - Residential Results
(% by weight)

Major Categories	AUGUST		NOVEMBER	
	Urban/Suburban WSI Transfer Stn (%)	**Rural** Waste USA (%)	**Urban/Suburban** WSI Transfer Stn (%)	**Rural** Waste USA (%)
Paper	18.3%	18.3%	20.6%	20.3%
Plastic	10.2%	8.3%	8.7%	9.7%
Metal	4.5%	4.6%	4.5%	5.2%
Glass	1.6%	3.8%	2.9%	2.3%
Organic [(1)]	39.1%	38.8%	26.8%	33.6%
Other Waste	26.3%	26.3%	36.5%	28.9%
	100.0%	100.0%	100.0%	100.0%

[(1)] Includes Dirty paper

- There is a significant amount of "dirty paper" (approximately 9%), especially paper plates and cups, in the waste stream.

- Food wastes (approximately 21%) were the largest single material on a weight basis found in the residential waste stream. Therefore, organics management systems may be an important method for increasing diversion.

- Hazardous materials appear to be a relatively small fraction of the waste stream (0.5%).

- Textiles are a significant enough part of the residential waste stream (5%) to consider further development of collection and marketing programs for this material.

- There were relatively insignificant quantities of both electronics (1.8%) and C&D waste (4.2%) in all of the samples.

Commercial Waste Composition

Tables E.3 – E.8 summarize the results of the commercial waste sorts using the same recyclable material categories as for residential waste (Figure E.1) but including clean plastic film under the potentially recyclable plastic.

Office Wastes

Six samples totaling 1,392 pounds of office waste were sorted. Table E.3 illustrates the composition of the office waste samples. As expected, paper is the largest single category, averaging 32 percent on a weight basis. The majority of the waste paper was white paper and non-white mixed papers, both of which are potentially recyclable. Magazines and other coated stock would also be recyclable.

Table E.3
Office Sector Results
(% by weight)

	AUGUST	NOVEMBER
Recyclable Paper	22.7%	38.3%
Recyclable Plastic [(1)]	3.3%	2.3%
Ferrous & Aluminum Cans	3.2%	0.9%
Glass Bottles	5.7%	1.4%
Organic [(2)]	18.9%	18.9%
Remaining Waste	46.6%	38.2%

(1) Includes plastic bottles and clean plastic film
(2) Exclusive of dirty paper

Retail Establishments

Seven samples totaling 1,108 pounds of retail waste were sorted from a fairly broad spectrum of retail types. As such, as illustrated in the individual samples in Appendix A, there is a fairly wide range of composition. However, as illustrated in Table E.4, recyclable paper again represents the largest single category. In some cases corrugated containers were significant, especially in the August sorts, indicating that more could still be done to divert additional corrugated containers from the retail sector.

Table E.4
Retail Sector Results
(% by weight)

	AUGUST	NOVEMBER
Recyclable Paper	35.6%	21.0%
Recyclable Plastic [(1)]	7.5%	9.1%
Ferrous & Aluminum Cans	1.1%	1.4%
Glass Bottles	2.9%	1.3%
Organic [(2)]	13.6%	15.4%
Remaining Waste	39.3%	51.8%

(1) Includes plastic bottles and clean plastic film
(2) Exclusive of dirty paper

Restaurants

Five samples totaling 1,640 pounds of restaurant wastes were sorted. As illustrated by Table E.5, organics dominated the restaurant waste stream, averaging 58 percent. Potentially recyclable plastic film was also significant (averaging 5.6%), although much of the plastic film was covered with food waste which increased its relative weight, and which also lowers its potential for recycling.

Table E.5
Restaurant Results
(% by weight)

	AUGUST	NOVEMBER
Recyclable Paper	5.2%	12.8%
Recyclable Plastic [(1)]	9.4%	4.7%
Ferrous & Aluminum Cans	1.1%	0.9%
Glass Bottles	2.2%	1.3%
Organic [(2)]	59.9%	56.4%
Remaining Waste	22.2%	23.9%

(1) Includes plastic bottles and clean plastic film
(2) Exclusive of dirty paper

Grocery

Six samples totaling 1,837 pounds of grocery wastes were sorted. As illustrated in Table E.6, grocery wastes were also dominated by organic wastes (primarily food waste). However, a review of the individual grocery samples in Appendix A indicates that some grocery stores were separately managing organic wastes while others were not. Location of the store within a reasonable hauling distance of the Intervale Composting Facility did not appear to be a factor in whether the store diverted organics.

Table E.6
Grocery Sector Results
(% by weight)

	AUGUST	NOVEMBER
Recyclable Paper	46.3%	20.1%
Recyclable Plastic [(1)]	2.6%	5.2%
Ferrous & Aluminum Cans	0.8%	1.1%
Glass Bottles	2.6%	1.6%
Organic [(2)]	39.4%	54.5%
Remaining Waste	8.3%	17.5%

(1) Includes plastic bottles and clean plastic film
(2) Exclusive of dirty paper

Motels/Hotels

Two samples totaling 392 pounds of motel wastes were sorted. The small sample size was the result of adding motels as a separate category in November. However these samples represent over ten motel and hotel establishments. Dirty paper (12.3%) represented a significant amount of waste. And, although not reflected in Table E.7, plastic garbage bags were significant, reflecting the common practice of lining all waste cans in each hotel room with clear plastic bags which are then removed each day, even though they might contain only tiny amounts of waste.

Table E.7
Hotels/Motels Sector
(% by weight)

	NOVEMBER
Recyclable Paper	27.4%
Recyclable Plastic (1)	5.1%
Ferrous & Aluminum Cans	1.1%
Glass Bottles	9.0%
Organic (2)	20.4%
Remaining Waste	37.0%

(1) Includes plastic bottles and clean plastic film
(2) Exclusive of dirty paper

Mixed Commercial

During the August sampling period DSM sorted 14 samples totaling 5,087 pounds of mixed commercial wastes. In addition to the average composition of the 14 samples, a low and high range for each material category is included in Table E.8 to illustrate the fundamental difficulty with waste composition sorting of mixed commercial loads. As Table E.8 indicates, there are wide variations in material composition depending on the types of generators in the sampled load, as well as the area of the load sampled.

Table E.8
Mixed Commercial Load Results
(% by weight)

	Average	*Low*	*High*
Recyclable Paper	20.2%	9.4%	56.4%
Recyclable Plastic (1)	4.9%	0.2%	13.6%
Ferrous & Aluminum Cans	1.6%	0.0%	4.9%
Glass Bottles	1.6%	0.0%	3.7%
Organic (2)	36.6%	4.2%	51.8%
Remaining Waste	35.1%	4.3%	59.4%

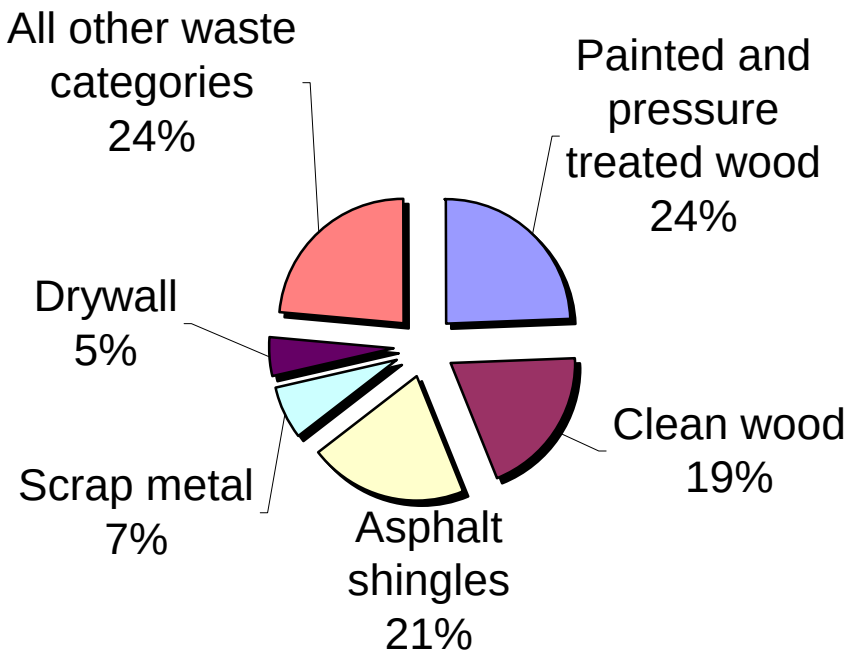
(1) Includes plastic bottles and clean plastic film
(2) Exclusive of dirty paper

Construction and Demolition Wastes

DSM observed a total of 50 C&D waste loads at the two sorting locations during the two weeks of sampling in August, 2001. Figure E.2 displays the compilation of these observations. The percentages in Figure E.2 were calculated by weighting the percentage *volume* estimate from each load observed by the weight of that load to account for differences between 100-yard trailers and small truckloads. It should be noted that the composition estimates were all made based on volume and not adjusted for the differences in material densities.

Wood waste made up between 33 and 54 percent of the total volume of the loads Wood Waste made up between 33 and 54 percent of the total volume of the loads observed, with clean wood totaling between 17 and 32 percent by volume. Second to wood waste was asphalt shingles totaling between approximately 15 and 26 percent by volume.

Figure E.2
C&D load observations
(% by volume)



INTRODUCTION

During the summer of 2001, DSM Environmental Services, Inc. (DSM) was contracted by the Solid Waste Program of the Vermont Department of Environmental Conservation (VT DEC) to conduct waste sorting at the Waste USA landfill in Coventry, VT and the WSI transfer station in Burlington, VT. DSM sub-contracted with the Chittenden Solid Waste Management District (CSWMD) for assistance with logistics and sorting at the WSI Transfer Station. These two locations were chosen to represent the urban/suburban (Chittenden County) and rural (Waste USA) populations of Vermont, and to identify any differences in waste composition between these two populations.

Sorting was carried out at the Waste USA landfill for five days in August (20 – 24th), and three days in November (19 – 21st) and at the WSI transfer station for five days in August (27 – 31st), and four days in November (5-8th). These sorting periods were selected to represent two seasons, with the hope of determining whether there were seasonal differences in Vermont's waste composition.

Samples of residential and commercial wastes were sorted at both locations. During the first sampling period in August, mixed commercial loads were selected for sampling. However, based on the wide range in composition due to the heterogeneous nature of commercial wastes, only "pure" loads of specific commercial generator categories were sorted in November (see below).

This report presents the results of the four sorting events for both residential and commercial wastes. In addition, DSM performed a limited study of the composition of Construction and Demolition (C & D) waste. The results of these observations are also presented in this report.

OBJECTIVES OF THE WASTE COMPOSITION ANALYSIS

The primary objective of the sampling program was to collect data on the composition of the waste stream for use by the VT DEC and solid waste districts to better target future waste reduction and diversion programs. As such, the categories selected for sorting were based on what can currently be recycled in Vermont as well as materials that might have potential for future diversion (such as organic wastes). The second objective was to search for categories of concern, such as electronics wastes and potentially hazardous wastes. Finally, VT DEC was interested in the potential for additional diversion of construction and demolition wastes.

It is important to note here that sorting waste material destined for the landfill does not provide information about the behavior of the generator with respect to waste reduction and recycling activities. The results only provide information on what the generator chose to dispose of. As such, one can only speculate about what the waste composition means with respect to waste generation and recycling behavior. Therefore, while DSM has made observations about potential implications of this study, verification would require studies targeting waste generation and diversion.

METHODOLOGY

Waste Sort Categories

Tables 1, 2, and 3 describe the categories into which the residential and commercial samples were sorted, and the categories by which the C&D waste were categorized. The following notes concerning the material categories may be useful when reading this report.

- The "all other organic" category consisted primarily of food waste. The organic wastes were negatively sorted and then shoveled off the floor of the sorting area and categorized as "all other organic." In a "negative sort" other materials are removed ("positively sorted") leaving a pile of material which is assumed to be all organic waste. Given the nature of a negative sort, and the difficulty of sorting through this material, the "all other organic" category necessarily contains small quantities of non-organic material such as broken glass, foil wrappers, and inerts (dirt, stone). DSM *estimates* that these other materials represented approximately 10 percent (by weight) of the organic waste category. Thus, if "all other organic" were 30 percent by weight of the total material sorted, then non-organic material remaining in the organic material would represent three percent of the total material sorted (0.3 x 0.1).

In the final stages of a negative sort of "all other organic" wastes

- For all but the last two days of the first round of sorting "dirty paper" (e.g., paper plates, napkins, paper towels, tissues) were included in the "all other organic" category. However, given the quantities of these dirty paper materials observed, at least on a volume basis, it was decided during the last two days of the first round of sorting to positively sort dirty paper from the organic wastes. This procedure was followed throughout the second round of sorting. Therefore, for comparison purposes, it is necessary to subtract "dirty paper" from the November paper category and add it to the "all other organics" category for consistent comparison between the August and November results.

- Because of the amount of moisture absorbed during the collection and compaction process, the paper categories appear to be greater than they actually were at the time they were set out for collection. Based on an analysis conducted by DSM at the ROT composting facility in Hanover, NH, the paper could weigh twice as much saturated, as it would when originally set out for collection. During the first round of sampling in August, we encountered significantly wetter paper than during the November sampling, both as a result of greater quantities of wet organic wastes during August, and more rainfall. The wetness of the paper varied significantly, but based on our observations we have made the judgment that the paper was on average 30 percent heavier because of moisture absorbed in the compaction truck. As such, we have adjusted the reported August paper weights down by 30 percent to reflect this absorption of water. We did not adjust the November paper categories to account for excess moisture because the waste was much dryer. In addition, we did not adjust the weight of any other categories up when we subtracted 30 percent from the paper weights in August.

- Attempts were made to empty the contents out of any partially filled bottles and cans. However, if the bottle or can was full, then the full container was placed in the "other waste" category because the container was assumed to be unavailable for recycling.

- The "other waste" category acted as a catch-all for materials which have limited recycling potential given current technologies. This included baby and adult diapers, multi-material packaging (e.g., fiber/metal frozen orange juice containers), cat litter, plastic trash bags used for garbage, and, as stated above, full food or beverage containers.

- The broad category of "film" included all potentially recoverable films such as grocery bags, food wraps, and snack food bags. A visual examination of the samples would indicate that there was a significant volume of film. However, because of the lightweight nature of film, the category is relatively small as a percentage of total weight. And, because of the large surface area of film, contaminants on the film probably make up as much as 40 to 50 percent of the weight reported, especially in the restaurant and grocery categories where the film was highly contaminated with moisture and food residues.

TABLE 1.
Sort Categories Used for Residential Waste

	Category	Description
1	Newspaper and inserts	All newspaper and shoppers inserted in newspapers
2	Corrugated and kraft bags	Corrugated cardboard, including clean corrugated pizza boxes, and kraft bags/paper
3	Mixed paper	White, office, colored and other paper, junk mail, softcover books, telephone books
4	Magazine and coated paper	Magazines, catalogues and all other coated papers.
5	Boxboard (chipboard)	Cereal boxes, chipboard and other paper food package boxes including clean pizza boxes made from chipboard
6	Coated Boxboard (waxed/film coated)	Frozen food containers and twelve pack soda and beer containers
7	Dirty Paper	Paper products that are typically too contaminated for recycling but that would break down easily during composting such as paper towels, napkins, etc.
8	Plastic bottles	All #1 - 7 resin plastic bottles
	deposit plastic bottles sub-sort	All beverage containers with the 5 cent deposit indicia
9	Plastic tubs	Dairy containers and other #1 - 7 resin plastic tubs
10	Plastic containers	Foamed polystyrene "clamshells", deli containers and other non-dairy food containers.
11	Plastic film	Grocery sacks, shrink wrap, clean plastic wrap, film food packaging
12	All other plastic	Plastic products not categorized above
13	Ferrous cans	Steel and bi-metal food cans
14	All other ferrous	Scrap metal, brown and white goods
15	Aluminum cans	Beverage containers and any other aluminum cans
	deposit aluminum cans sub-sort	All beverage containers with the 5 cent deposit indicia
16	Glass bottles and jars	Mixed glass bottles and jars, not sorted by color
	deposit glass bottles sub-sort	All beverage containers with the 5 cent deposit indicia
17	Aseptic Containers	Milk, juice and other aseptic drink containers
18	Leaf and yard waste	Leaves, grass, small branches, brush
19	All other organic	Primarily food wastes but also included "dirty paper" during most August sorts
20	Hazardous waste	Lead acid and dry cell batteries, waste oil, paint, cleaners, lamps, solvents, etc.
	Mercury containing products sub-sort	Lamps, hearing aid batteries, etc.
21	Textiles	Clothing, towels, blankets
22	Bulky waste	Furniture, mattresses, swing sets, etc.
23	Electronics	Computers, televisions, VCRs, CD players/stereos, radios, printers
24	Tires	Car and truck tires
25	Construction waste	Wood, roofing shingles, sheetrock, flooring, etc from new construction and demolition
26	All other waste	Category for all other non-organic wastes

TABLE 2.
Commerical Waste Composition - Additional Sort Categories

Sector	Additional Sort Categories	Description
Retail	White Office Paper	White office and computer paper
	Waxed Corrugated	Corrugated containers with wax coating typically used for produce or other refrigerated food products.
	Books	Soft and hard cover books
	Clean Film	Clear or white stretch or packaging film that was clean of dirt, printing or excessive tape.
	Styrofoam	Foam packaging materials including EPS
	Clean Wood	
Office	White Office Paper	White office and computer paper
	Clean Film	Clear or white stretch or packaging film that was clean of dirt, printing or excessive tape.
	Books	Bound books
	Styrofoam	Foam packaging materials including EPS
Hotel/Motel	White Office Paper	White office and computer paper
	Clean Film	Clear or white stretch or packaging film that was clean of dirt, printing or excessive tape.
Restaurant	Food waste	Food waste
	All other organic waste	Leaf and yard waste, dirt and all other non-food waste
	Clean Film	Clear or white stretch or packaging film that was clean of dirt, printing or excessive tape.
Grocery	Waxed Corrugated	Corrugated container with wax coating typically used for produce or other refrigerated goods.
	White Office Paper	White office and computer paper
	Clean Film	Clear or white stretch or packaging film that was clean of dirt, printing or excessive tape.

Sorted mixed plastic film

TABLE 3.
Sort Categories Used for Visual Allocation of Construction and Demolition Waste

Category	Description
1 Asphalt shingles	Asphalt roofing shingles in whole or in part.
2 Clean wood	Unpainted, unstained, and untreated wood pieces with and without nails.
3 Painted and pressure treated wood	Painted, stained, treated or otherwise altered wood pieces.
4 Drywall	Otherwise known as sheetrock, wall board, etc.
5 Asphalt, brick and concrete (ABC) waste	Any asphalt pieces, concrete or concrete blocks, bricks or other masonry.
6 Corrugated cardboard	
7 Scrap metal	Any scrap metal object, including metal appliances or any object that is primarily metal.
8 Insulation	Fiberglass, foam or any other type of insulation
9 Tiles and flooring	Ceramic and linoleum tiles and flooring material including all non-wood flooring material.
10 Plastic Film	Clean and dirty shrink wrap and plastic film
11 Rugs	Carpeting, rugs
12 Salvage Items	Doors, windows, porcelain fixtures and other items used in new construction and renovations that could be reused.
13 Furniture	Chairs, couches, mattresses and other furniture
14 Hazardous wastes	Lead acid and dry cell batteries, paints, solvents, stains, waste oil, cleaners, lamps, etc.
Mercury containing wastes	Lamps, batteries, etc.
15 All other C&D waste	Any other construction or demolition waste that doesn't fit into the above listed categories as well as household wastes, and electronics, and bedding

Load Selection

Residential

One of the goals of the residential load selection process was to evaluate Chittenden County waste separately from more "rural" areas of Vermont to determine if there were any differences in the waste composition. As such, DSM worked with Waste USA personnel at the scale house to identify and select only pure residential loads from rural towns in the Northeast Kingdom as well as pure residential loads from St. Johnsbury and Newport. "Pure" loads are defined as containing waste from only one type of generator (in this case residential), as opposed to mixed loads of residential and commercial wastes.

In Chittenden County an attempt was made to sample loads from a wide range of Chittenden County routes/municipalities. While we primarily concentrated on sampling residential loads delivered by WSI to their transfer station, we did sort two All Cycle loads for comparison purposes. We did not see any appreciable differences.

Commercial

Loads sampled during the August sorting at Waste USA were primarily mixed commercial loads while at WSI (in August) we sorted a number of "pure" loads from specific generator categories as well as some mixed commercial loads. In the case of commercial loads, "pure loads" are defined as those from a specific commercial generator type (e.g., restaurants or offices) as opposed to mixed loads containing waste from different types of generators.

During the second round of sampling in November we sorted only "pure" commercial loads from specific generator categories at both Waste USA and WSI. This was because the mixed commercial loads sampled in August had such a wide range in composition that it appeared the data would not be as useful as it could be for planning and management purposes. The generator categories selected for sampling were:

- Offices
- Retail
- Food Stores
- Restaurants
- Hotels/Motels (November only)

The tables for commercial wastes present the data from the specific generator categories first and then the data from the mixed loads for comparison purposes.

Construction and Demolition Waste

Performing an analysis of C&D waste composition is resource intensive for two reasons:

- It is physically difficult to sort C&D waste without mechanized equipment, large containers, and scales to weigh the containers; and,
- C&D waste varies significantly requiring sorting of a large enough sample size to represent all the different types of construction, renovation and demolition jobs.

Due to the funds available for the Vermont waste composition study, DSM and the VT DEC agreed that a visual estimate of the composition of C&D waste would be conducted during residential/commercial waste composition sorting at the two sorting locations. To accomplish this DSM observed the unloading of a majority of the "pure" C&D loads delivered at the WSI transfer station and the Waste USA landfill during the ten sort days in the month of August. As each load was dumped DSM made a visual estimate of the composition of the load. No visual estimates of C&D waste composition were carried out during the November sorting period.

Sampling Protocol

Residential

DSM used the California Integrated Waste Management Board (CIWMB) *Uniform Waste Disposal Characterization Method* methodology to determine the number of residential samples necessary to characterize the waste. The CIWMB methodology assumes that 30, 200 pound samples, distributed over a minimum of two seasons, can be "considered to be statistically representative" of the waste delivered to the sampling location. Therefore, DSM proposed to sort 15 residential samples at each location over each sample period (August and November), for a total of 30 samples per location (60 samples total).

DSM did not, as part of the scope of work, propose to statistically evaluate the data for two reasons. First, to determine the mean, 90 percent confidence intervals, and standard deviation for individual material categories by site and generator type would be difficult. This is because sufficient data from other composition studies are not available for some of the material categories (e.g., hazardous wastes, electronics) to determine the mean and standard deviation (which are necessary to determining sample size).

Second, in DSM's opinion, statistical validity would apply only to the populations sampled from the two locations in Vermont, and could not necessarily be extrapolated to other areas of Vermont.

However, as discussed below, the results of the August round of residential sampling at the two locations were so similar that it appeared likely that residential waste composition throughout Vermont would be similar. Therefore, it was agreed to reduce the number of residential samples during the second round of sampling to concentrate more on commercial waste sorting.

Commercial

Initially, VT DEC elected to sample mixed commercial loads. However, as discussed above there was a wide range in composition observed during the August sampling. As a result, it was decided to modify the sample selection during the November sorting period to concentrate on specific commercial generator categories. Table 4 lists the five commercial generator categories sampled and the source of the loads within those categories.

TABLE 4.
Sources of Pure Commercial Loads, August and November 2001

Sector	Load #	Source of Load	Date Sorted
Retail	**1**	Discount Department Store	29-Aug
	2	Mall (Health & beauty, pet store, clothing, sporting goods)	30-Aug
	3	Mall (Clothing, gifts, shoes, books, dept store)	5-Nov
	4	Florist, Pharmacy, Hardware, Clothing & Sporting Goods Store	5-Nov
	5	Signs, Auto Accessories, Tile Shop, Farm Store (hardware, clothing, tools)	7-Nov
	6	Discount Dept Store, Clothing, Department Store, Electronics Store	19-Nov
	7	Mall	20-Nov
Office	**1**	Professional Center, Construction Firm, Investment Firm, Post Office	29-Aug
	2	Technology Firm	30-Aug
	3	Real Estate Development, Bank, Real Estate, Professional Center	5-Nov
	4	Cell Phone Co, Bank, Financial Services, Post Office	6-Nov
	5	Property Management Office, Lab, Engineering Firm Professional Center, Consulting	7-Nov
	6	Insurance Company	19-Nov
Hotel/Motel	**1**	Motels (2), Inn	6-Nov
	2	Residence Inns (2), Motel	7-Nov
Restaurant	**1**	Sit Down (3), Fast Food	27-Aug
	2	Fast Food, Sit Down	29-Aug
	3	Sit Down and Take Out, Take Out, Fast Food	6-Nov
	4	Sit Down and Take Out, Fast Food, Sit Down (2)	8-Nov
	5	Sit Down (4), Fast Food (2) and Take Out (2)	21-Nov
Grocery	**1**	Supermarket	23-Aug
	2	Supermarket	28-Aug
	3	Supermarket	7-Nov
	4	Supermarket	8-Nov
	5	Supermarket	19-Nov
	6	Covenience Stores	19-Nov
Total:	**26**		

No attempt was made to sample sufficient loads within each commercial category to generate statistically valid results (CIWMB recommends 25, 125 pound samples per category). However, the data provide useful information for planning and management purposes.

Construction and Demolition

Throughout the ten days of sampling in August DSM performed a visual assessment of the composition of the C&D loads as they were dumped. DSM first collected information on the source of the load and the type of construction job, if it was available from the driver. DSM then physically observed and recorded the composition of the load, estimating the percentage volume of seventeen different categories of construction and demolition waste.

DSM also noted any unusual conditions about the load on the data sheet and obtained the scale weight of the load.

Table 5 illustrates the reported breakdown of the sources of C&D waste observed. However, it should be noted that the breakdown of sources is based on information provided by the truck drivers. Often they were making an educated guess about what type of source they were picking up from. And, all of the large 100-yard loads observed at Waste USA contained an unknown mix of material from transfer stations. For this reason no attempt has been made to categorize the observations by generator type.

TABLE 5.
Source of Construction Waste Loads, by Job Type

Type of Construction	Sorting Location		Combined	
	Waste USA	WSI		
	(# loads)	(# loads)	(# loads)	(%)
Residential				
New construction	1	3	4	8%
Demolition	5	4	9	18%
Renovation	6	7	13	26%
Roofing	4	2	6	12%
Clean out	2	6	8	16%
Commercial				
New construction	1	1	2	4%
Demolition	2	1	3	6%
Renovation	1	2	3	6%
Mixed C&D (more than one job)	2	0	2	4%
Total, Loads Observed:	**24**	**26**	**50**	100%
Total Weight, All Loads (tons)	**97.2**	**69.2**	**166**	
Estimated Volume, All Loads (cubic yards) [(1)]	634	415	1,049	

[(1)] This was estimated from observations of load sizes and container sizes, but measurements were not taken.

Sample Selection

The goal was to take 200-pound and 150-pound samples from each of the identified residential, and commercial loads, respectively. To eliminate sample bias during selection of the sample location within each truck-load, two methodologies were used.

During the August sorts the sample was selected from the truck-load of waste by mentally creating a grid for each emptied load by dividing it horizontally and then vertically to create 12 "blocks" of waste. We then systematically chose the sample location by starting at block 1 and going up during the day, beginning the next day where we left off the first day. For example, if we sampled two residential loads, and then two commercial loads and then a third residential load on day one, we would take the sample from block 1 for the first residential sample, block 2 for the second residential sample, and block 3 for the first commercial sample, ending the day with block 5, and beginning the next day with block 6. However, in some cases with the mixed commercial loads we would, after talking with the driver, choose to avoid a portion of the load that contained apartment waste or hospital wastes, so the block selection was not purely random in these cases.

Based on the physical difficulties of extracting a bucket-load sample from the grid location we had selected (especially middle upper portions of the load, where the bucket would tend to push the waste rather then pick it up), it was decided for the November sort to simply always take the sample from the same location in the pile (the last material unloaded from the truck) for all samples. This eliminated any bias in selecting samples, and allowed the loader operator to go in from the bottom of the pile and lift up.

Number of Samples and Sample Size

Table 6 lists the number of samples and the average sample size (in pounds) for each generator category. Over the two sorting periods, 24,626 pounds from 91 samples were sorted. Fifty-one residential loads and 40 commercial loads were sampled, with an average sample size of 258 pounds for residential waste and 286 pounds for commercial waste.

It should be noted that using a large bucket loader to take a 200-pound sample is an art rather than a science. While we got better as the weeks went on, we did not consistently get similar weight samples. Lighter weight materials, such as packaging materials from retail wastes, were especially difficult, as were very heavy materials such as food wastes from restaurants and grocery stores.

TABLE 6.
Number of Samples and Sample Size

Generator Type	Number of Samples	Average Sample Size	Total Sample Size
Residential	(#)	(lbs.)	(lbs.)
August, Waste USA	15	295	4437
August, WSI	15	209	3139
November, Waste USA	9	239	2,150
November, WSI	12	287	3,445
Sub-Total	**51**	**258**	**13,171**
Commercial			
Retail	7	158	1,108
Office	6	232	1,392
Restaurants	5	328	1,640
Grocery	6	306	1,837
Motels	2	196	391
Mixed Commercial Loads	14	363	5,087
Sub-Total	**40**	**286**	**11,455**
Total	**91**	**n/a**	**24,626**

Sorting Procedure

Each sample was dumped on a clean area of the tipping floor (WSI) or on a tarp under cover at Waste USA. Plastic barrels for each material were then lined up around each sample in a logical order (e.g., all paper categories together, all bottles and cans together). The sorters then pulled materials out of the sample and placed them in the proper barrel. When the barrels were full they were weighed on a portable scale and the gross and tare weight recorded by material type. At the end of each sample the remaining pile was shoveled into barrels as "all other organic waste" and weighed.

All weight data were recorded by one of the two DSM partners. All questions concerning the proper category to sort specific material in to were addressed by the same DSM partners who were present on all days of sorting. All sorters were trained prior to sorting.

Sorting into barrels by material type

PRESENTATION OF RESULTS

The following sections are organized by generator type, with all of the residential samples summarized and discussed first, followed by similar summaries/discussions about each of the five commercial generator categories and the mixed commercial load samples. Finally the results of the C & D composition observations are presented.

The sort results from each individual sample from which the summary tables are compiled are included in Appendix A for reference.

Residential

Tables 7.a and 7.b summarize the results of the waste composition sorts of 51 samples of residential waste representing a total of 13,171 pounds of solid waste. Each of the major residential waste material categories are discussed below.

Paper

Paper remains the single largest category of potentially recyclable material[1] in the residential waste stream, and the second largest category of material overall (if "dirty paper" is included).

The paper category can be divided into two paper types: "clean paper" and "dirty paper". During the August sort, "dirty paper" (e.g., tissue, paper towels, paper plates and cups) was included in the "all other organic" category, because it was assumed that this paper would not be available for recycling, but could be included in an organics management system. However, as it became obvious that this category represented a significant amount of material, the sorting procedure was changed in the last few days of the August sorting to separate the majority of this "dirty paper" out of the organic fraction. This provided a better illustration of the role of paper in the waste stream, and also provides better information for those looking to compost the organic fraction, since food waste and paper have different carbon/nitrogen ratios.

Therefore, there are significant differences in Tables 7.a and 7.b in the paper and organic subtotals between August and November due to the addition of "dirty paper" to the paper category during the November sorts. Deducting the "dirty paper" from the November paper subtotal yields almost identical quantities of "clean paper" (18-20 percent of total waste) across both sort periods, and across "urban/suburban" and "rural" categories.

Excluding books and coated boxboard, which are typically not recycled in residential programs, from the "clean paper" category, approximately 16 to 17.5 percent of total urban and rural residential waste respectively, remains potentially recyclable paper.

[1] "Potentially recyclable" is defined as material that is currently accepted by the majority of recycling programs in Vermont.

TABLE 7.a
Residential Waste, Percent by Weight

	August		November	
Category	**Urban Suburban** (WSI Transfer Station)	**Rural** (Waste USA)	**Urban Suburban** (WSI Transfer Station)	**Rural** (Waste USA)
Paper	%	%	%	%
Newspaper and inserts [1]	2.4%	2.7%	2.9%	2.7%
Corrugated and kraft bags [1]	2.7%	3.8%	6.0%	4.7%
Mixed paper [1]	4.6%	4.3%	3.9%	4.7%
Dirty Paper [1][2]	0.0%	0.0%	9.5%	8.0%
Magazine and coated paper	3.6%	3.6%	1.6%	2.8%
Books	0.5%	0.0%	1.9%	0.1%
Boxboard	2.3%	3.1%	1.7%	2.6%
Coated boxboard	2.2%	0.8%	2.6%	2.5%
Paper Subtotal	**18.3%**	**18.3%**	**30.1%**	**28.2%**
Plastic				
Plastic bottles	1.4%	2.2%	0.9%	2.3%
Plastic bottles-deposit	0.3%	0.2%	0.0%	0.0%
Plastic Clamshells	0.0%	0.0%	0.8%	0.7%
Plastic tubs [3]	0.6%	0.4%	0.2%	0.3%
Plastic film	3.1%	2.7%	3.2%	2.7%
All other plastic	4.9%	2.8%	3.6%	3.6%
Plastic Subtotal	**10.2%**	**8.3%**	**8.7%**	**9.7%**
Metal				
Ferrous cans	1.2%	1.8%	1.2%	2.0%
All other ferrous	2.7%	2.0%	2.9%	2.0%
Aluminum cans	0.5%	0.5%	0.3%	1.2%
Aluminum cans - deposit	0.1%	0.2%	0.0%	0.1%
Metal Subtotal	**4.5%**	**4.6%**	**4.5%**	**5.2%**
Glass				
Glass bottles & jars	1.6%	3.4%	2.6%	2.2%
Glass bottles & jars - deposit	0.0%	0.4%	0.3%	0.1%
Glass Subtotal	**1.6%**	**3.8%**	**2.9%**	**2.3%**
Organic				
Food/All other organic	37.1%	38.5%	17.0%	25.6%
Leaf and yard waste	2.0%	0.3%	0.3%	0.0%
Subtotal Organic	**39.1%**	**38.8%**	**17.3%**	**25.6%**
Other				
Hazardous waste	0.9%	0.6%	0.6%	0.1%
Mercury containing waste	0.0%	0.0%	0.0%	0.0%
Textiles	4.4%	3.4%	5.6%	7.4%
Bulky waste	2.6%	0.2%	0.0%	2.5%
Electronics and small appliances	0.5%	1.1%	4.2%	1.3%
Tires	0.0%	0.0%	0.0%	0.0%
Construction waste	1.8%	6.3%	6.3%	2.5%
All other waste	16.0%	14.7%	19.8%	15.2%
Other Waste Subtotal	**26.3%**	**26.3%**	**36.5%**	**28.9%**
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

[1] Weights adjusted for moisture content (reduced by 30%)

[2] Dirty paper included in "Food/All other Organic" in August "rural" sort.

[3] Plastic Tubs include clamshells (food service polystyrene) in August sort.

[4] Numbers may not add due to rounding

TABLE 7.b
Residential waste, Comparision of Urban/Suburban and Rural, Percent by Weight [1]

Category	Urban/Suburban	Rural	Combined
Paper	%	%	(%)
Newspaper and inserts	2.7%	2.7%	2.7%
Corrugated and kraft bags	4.4%	4.3%	4.3%
Mixed paper	4.3%	4.5%	4.3%
Dirty Paper [2]	9.5%	8.0%	8.8%
Magazine and coated paper	2.6%	3.2%	2.9%
Books	1.2%	0.0%	0.6%
Boxboard	2.0%	2.9%	2.5%
Coated boxboard	2.4%	1.7%	2.0%
Paper Subtotal	**29.1%**	**27.3%**	**28.1%**
Plastic			
Plastic bottles	1.1%	2.2%	1.7%
Plastic bottles-deposit	0.1%	0.1%	0.1%
Plastic Clamshells	0.4%	0.2%	0.3%
Plastic tubs	0.4%	0.4%	0.4%
Plastic film	3.1%	2.7%	2.9%
All other plastic	4.2%	3.1%	3.6%
Plastic Subtotal	**9.3%**	**8.7%**	**9.0%**
Metal			
Ferrous cans	1.2%	1.9%	1.5%
All other ferrous	2.8%	2.0%	2.4%
Aluminum cans	0.4%	0.7%	0.6%
Aluminum cans - deposit	0.1%	0.2%	0.1%
Metal Subtotal	**4.5%**	**4.8%**	**4.6%**
Glass			
Glass bottles & jars	2.1%	3.0%	2.6%
Glass bottles & jars - deposit	0.2%	0.3%	0.2%
Glass Subtotal	**2.3%**	**3.3%**	**2.8%**
Organic			
Food/All other organic [2]	17.0%	25.6%	21.3%
Leaf and yard waste	1.1%	0.2%	0.7%
Subtotal Organic	**18.1%**	**25.8%**	**22.0%**
Other			
Hazardous waste	0.8%	0.5%	0.6%
Mercury containing waste	0.0%	0.0%	0.0%
Textiles	5.1%	4.7%	4.9%
Bulky waste	1.3%	0.9%	1.1%
Electronics and small appliances	2.4%	1.1%	1.8%
Tires	0.0%	0.0%	0.0%
Construction waste	4.1%	5.1%	4.6%
All other waste	18.0%	14.9%	16.4%
Other Waste Subtotal [3]	**31.7%**	**27.2%**	**29.4%**

[1] Dirty paper and organic averages across the August and November sorting events combine disparate data where some organic samples include dirty paper and some do not. Refer to Table 7.a and the text for a full explanation. All other categories are comparable across all sampling events.

[2] November sorts only

[3] Because of the way paper and organic categories are reported in this table, the totals do not add to 100 %.

Bottles and Cans

The other potentially recyclable category is "bottles and cans". Subtracting out plastics that are not currently collected for recycling (e.g., film, tubs, miscellaneous plastics), approximately 7 percent of the total residential waste stream is plastic and glass bottles, and ferrous and aluminum cans. As with paper, urban/suburban households are placing less of these recyclables in the garbage (perhaps due to more curbside collection programs in urban/suburban areas) than rural households. On average approximately 5 percent of urban/suburban residential waste is potentially recyclable bottles and cans compared to 8 percent of rural residential waste.

Deposit Containers

Sub-sorts of bottles and cans were carried out to identify how many deposit beverage containers were discarded. As illustrated by the waste composition tables, there were few deposit containers discarded in the waste stream, confirming the high capture rates for deposit containers reported in the literature.

Plastics

Plastics, other than plastic bottles, represented approximately 8 percent of the waste stream. Of particular interest is plastic film, representing an average of 3 percent. This is significant, given the lightweight nature of plastic film, although the weight of plastic film is exaggerated by the significant amount of moisture and dirt due to of the large surface area of the film. It is also interesting to note that the percent of plastic bottles on a weight basis are beginning to approach glass bottles. Given the lightweight nature of plastic bottles this illustrates the continued shift of packaging from glass to plastics.

Organics

The largest single category remaining in the waste stream is organic material – primarily food wastes. Assuming that "dirty paper" in August was similar to "dirty paper" in November, then the organic fraction ranged from a low of 17.3 percent ("urban/suburban", November) to a high of 37 percent ("urban/suburban", August).

These percentages should be reduced by an estimated three percent to account for broken glass and small pieces of paper, plastic, and other residue, remaining in the organic fraction that was shoveled up at the end of the sort.

Our observations are that the majority of the organic fraction was food waste – both food preparation waste and plate waste. It was higher in August because there was more fresh food available from gardens and markets. The difference in organic waste between seasons was not due to yard wastes (which had originally been anticipated), but instead to much lower quantities of food wastes present in the waste stream in November. In general, yard wastes remained relatively insignificant through out all the sorts. It is not

known whether the lack of yard waste was due to the abnormally dry summer or to resident's habits of disposing of yard waste on-site.

Other Wastes

"Other wastes" represent an average of 28 percent of the total residential waste stream. Of particular interest are potentially hazardous wastes, and textiles. Potentially hazardous wastes (or more accurately, wastes which could potentially pose an environmental threat from land disposal) represented approximately 0.7 percent of the total waste stream. Virtually none of this was mercury containing wastes.

Textiles were a significant amount of the waste stream, averaging 4 percent in August and 6.5 percent in November.

Electronics and other small appliances averaged 2 percent (rounded) over the four sorts.

Construction and demolition wastes averaged 3.3 percent of the waste stream, although this average was increased by the high amount in the "urban/suburban" WSI sorts (6.3 percent).

Observations On The Residential Waste Sorts

Figure 1 presents a graphic illustration of what is left in the Vermont residential waste stream after ten years of public and private investment in recycling and HHW collection systems and education programs. DSM's observations include:

- While the State has made impressive progress in increasing recycling of materials, approximately 24 percent of the residential waste stream remains recyclable paper and bottles and cans, which are accepted by most programs in Vermont. It is impossible to determine, without conducting capture rate studies, how difficult it would be to divert additional amounts of these potentially recyclable materials. Capture rate studies entail collecting and sorting material set out for recycling and material set out for disposal from a sample of households. The percent of each potentially recyclable material set out for recycling can be compared to the percent set out in the garbage. Materials with a high percentage set out for recycling (i.e., a high capture rate) have less potential for additional diversion than materials with low capture rates. Capture rate studies would indicate whether Vermont is approaching high levels of diversion (80% capture rates) of materials, or whether there is potential to significantly increase diversion because existing capture rates are low.

Figure 1.
Composition of Residential Waste
(% by weight)

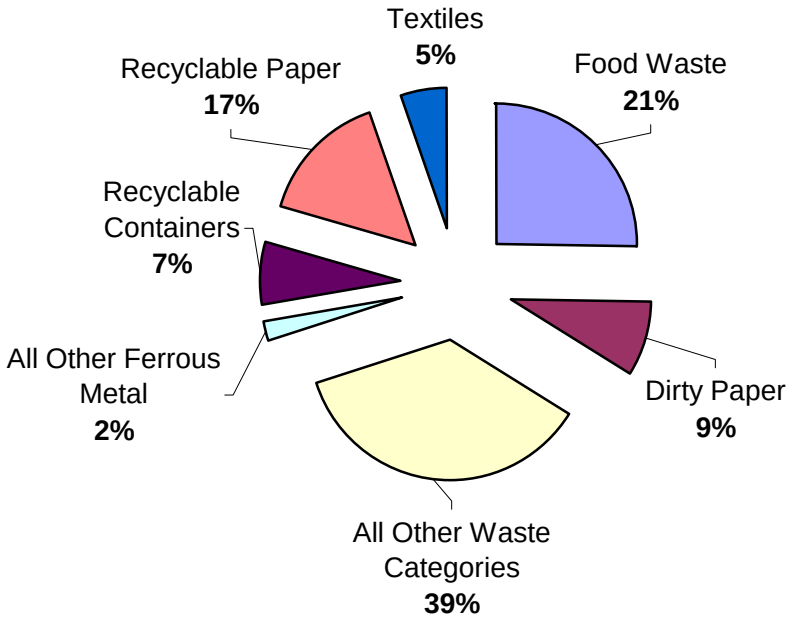


Figure 1.
Materials Included in Summary Categories

Summary Category	Categories Included
Recyclable Paper	Newspaper and inserts, Corrugated and kraft bags, Mixed paper, Magazine and coated paper, Boxboard
Recyclable Containers	Glass bottles and jars, Plastic bottles, Ferrous cans, & Aluminum cans – Deposit & non-deposit
All Other Ferrous	Brown and white goods
Food Waste	Food waste
Textiles	Textiles
Other Waste Categories	Books, Coated boxboard, Dirty paper, Plastic clamshells, Plastic tubs, Plastic film, All other plastic, Leaf and yard waste, All other organic, Hazardous waste, Mercury containing waste, Bulky waste, Electronics and small appliances, Tires, Construction waste, All other waste

- Non-bottle plastics are a growing part of the waste stream. Of particular significance are the relatively large amounts (on a volume basis) of plastic films (exclusive of garbage bags) in the waste stream. The new curbside collection programs in Seattle, Washington, which include residential films, may provide some guidance to evaluate the potential for film collection programs in Vermont in the future. Of particular importance will be markets for mixed color and resin films, because it would be impossible to require separate collection by color and

resin. The markets must also be capable of handling relatively high contamination rates due to the large surface area of film.

- There is a significant amount of "dirty paper", especially paper plates and cups in the waste stream indicating that many households take advantage of the convenience of disposable plates and napkins.
- Food wastes were the largest single material on a weight basis found in the residential waste stream. Therefore, organics management systems provide the potential for significantly increasing diversion. There are a wide range of technologies and systems potentially available to manage this material including: aerobic composting; sink grinders for discharge to waste water treatment plants; and, anaerobic decomposition, either separately, or as part of a "bio-reactor" landfill.
- Hazardous materials appear to be a relatively small fraction of the waste stream. And, interestingly, there did not appear to be a significant difference in quantities of these materials found in the waste stream between Chittenden County, which has the most highly developed HHW collection programs in Vermont, and northeast Vermont. There is no way to know from the waste composition studies whether hazardous materials are not being generated or are being generated but stored, or disposed of, in some other way.
- Textiles are a significant enough part of the residential waste stream to consider further development of collection and marketing programs for this material.
- There were relatively insignificant quantities of both electronics and C&D waste in all of the samples. This may be in part because these materials are collected separately from residential waste set-out at the curb, or because households store these materials instead of disposing of them.

Commercial Waste Composition

Office Wastes

Six samples totaling 1,392 pounds of office waste were sorted. Table 8 illustrates the composition of the office waste samples. As expected, paper is the largest single category, at 54 percent of total waste. However, as with the residential waste stream, "dirty paper" represented almost one-half of the paper category for the August sort. In August, the office waste loads received for sampling contained a significant amount of bathroom and lunchroom wastes. Efforts were made to avoid these waste areas in November, resulting in much lower levels of "dirty paper". Using the November samples as the more representative samples, the majority of the office waste paper was white paper and non-white mixed papers, both of which are potentially recyclable. Magazines and other coated stock would also be recyclable.

It is also interesting to note that plastic film was significant in this category, as was food wastes. Electronics wastes were not significant.

Finally, although a relatively small amount on a weight basis, recyclable bottles and cans were significant, and represent another area where more effort to increase recycling might be worthwhile.

Retail Establishments

Seven samples totaling 1,108 pounds of retail waste were sorted from a fairly broad spectrum of retail types. As such, as illustrated in the individual samples in Appendix A, there is a fairly wide range of composition. However, as illustrated in Table 9, paper again represents the largest single category. In some cases corrugated containers were significant, especially in the August sorts, indicating that more could still be done to divert additional corrugated containers from the retail sector.

Again, plastic film was significant, representing on average 10 percent of the total waste stream, with the majority of plastic film being clean film that might have some market value. All other plastics were also significant, although, except for plastic bottles, most of the remaining plastic has low recycling value.

TABLE 8.
Office

Category	August	November
Paper		
Newspaper and inserts	4.1%	3.3%
Corrugated and kraft bags	3.3%	8.7%
White office paper	8.3%	9.6%
Non-white mixed paper	3.2%	9.6%
Dirty Paper [1]	25.4%	13.7%
Books	0.5%	0.3%
Magazines, coated paper	2.8%	4.6%
Boxboard	1.0%	2.5%
Coated boxboard	5.6%	1.7%
Paper Subtotal	**54.2%**	**54.0%**
Plastic		
All Plastic bottles	1.8%	0.7%
Plastic bottles deposit	0.8%	0.2%
Plastic Film (clean)	0.7%	1.4%
Plastic Film (dirty)	2.8%	0.9%
Plastic Film Subtotal	*3.6%*	*2.3%*
Plastic clamshells	0.0%	0.5%
All other plastic	5.5%	3.0%
Foam	0.0%	0.3%
Plastic Subtotal	**11.6%**	**7.0%**
Metal		
Ferrous cans	2.4%	0.5%
All other ferrous	1.1%	1.9%
Aluminum cans and foil	0.5%	0.3%
Aluminum cans - deposit	0.4%	0.1%
Metal Subtotal	**4.3%**	**2.8%**
Glass		
Glass bottles and jars	5.7%	1.4%
Glass bottles and jars - deposit	0.0%	0.0%
Glass Subtotal	**5.7%**	**1.4%**
Organic		
Leaf and yard waste	0.4%	1.6%
Food/All other organic	18.5%	17.3%
Organic Material Subtotal	**18.9%**	**18.9%**
Other Waste		
Hazardous waste	0.0%	0.2%
Mercury containing waste	0.0%	0.2%
Bulky waste	0.0%	0.0%
Electronics	0.6%	0.6%
Construction waste	0.1%	5.3%
All other waste	4.7%	9.5%
Other waste Subtotal	**5.3%**	**15.9%**
Total	**100.0%**	**100.0%**

[1] Napkins and paper towels make up the vast majority of this category.

TABLE 9.
Retail Establishments

Category	August	November
Paper		
Newspaper and inserts	1.6%	3.6%
Corrugated and kraft bags	23.3%	6.0%
White Office Paper	1.2%	3.0%
Non-white mixed paper	1.7%	1.7%
Dirty Paper	4.0%	9.1%
Books	0.0%	0.0%
Magazines, coated paper	2.9%	4.1%
Boxboard	4.8%	2.7%
Coated boxboard	2.2%	3.3%
Paper Subtotal	**41.8%**	**33.4%**
Plastic		0.0%
Plastic tubs	0.0%	0.1%
Plastic Containers (not tubs)	0.0%	0.3%
All Plastic bottles	1.5%	1.4%
Plastic bottles deposit	0.3%	0.0%
Plastic Film (clean)	5.7%	7.7%
Plastic Film (dirty)	3.7%	2.5%
Plastic Film Subtotal	*9.4%*	*10.3%*
All other plastic	10.3%	5.0%
Foam	0.0%	1.0%
Plastic Subtotal	**21.4%**	**18.0%**
Metal		
Ferrous cans	0.6%	1.3%
All other ferrous	1.6%	9.3%
Aluminum cans and foil	0.4%	0.1%
Aluminum cans - deposit	0.1%	0.0%
Metal Subtotal	**2.7%**	**10.7%**
Glass		
Glass bottles and jars	2.9%	1.1%
Glass bottles and jars - deposit	0.0%	0.2%
Glass Subtotal	**2.9%**	**1.3%**
Organic		
Food/All other organic	13.6%	15.4%
Leaf and yard waste	0.0%	0.0%
Organic Subtotal	**13.6%**	**15.4%**
Other		
Hazardous waste	0.0%	0.7%
Mercury containing waste	0.0%	0.0%
Bulky waste	0.0%	0.0%
Textiles	2.2%	0.2%
Construction waste	1.2%	11.9%
All other waste	14.2%	8.4%
Other Waste Subtotal	**17.6%**	**21.2%**
Total	**100.0%**	**100.0%**

Restaurants

Five samples totaling 1,640 pounds of restaurant wastes were sorted. As illustrated by Table 10, there were no surprises, with organics dominating the waste stream at 64 percent. Again, plastic film was significant, although much of the plastic film was covered with food waste which increased its relative weight, and which also lowers its potential for recycling.

Sorting through restaurant waste

Grocery

Six samples totaling 1,837 pounds of grocery wastes were sorted. As illustrated in Table 11, grocery wastes were also dominated by food wastes. However, a review of the individual grocery samples in Appendix A indicates that some grocery stores were separately managing organic wastes while others were not. Location of the store within a reasonable hauling distance of the Intervale Composting Facility did not appear to be a factor in whether the store diverted organics.

As with retail establishments, some grocery stores were also better at separating corrugated containers then others, indicating room for improvement in paper recycling.

Motels/Hotels

Two samples totaling 391 pounds of motel wastes were sorted. The small sample size was the result of adding motels as a separate category in November. However these

samples represent over ten motel and hotel establishments. Here again dirty paper was a significant source of waste. And, although not reflected in Table 12, plastic garbage bags were significant, reflecting the common practice of lining all waste cans in each hotel room with clear plastic bags which are then removed each day, even though they might contain only tiny amounts of waste.

There was also the potential to increase recycling from the sampled hotels and motels, with both recyclable paper such as newspapers and magazines, and recyclable bottles and cans prevalent in the sampled waste.

Food waste was also significant due to the common practice of serving breakfast at many motels and hotels.

TABLE 10.
Restaurants

Category	August	November
Paper		
Corrugated and kraft bags	2.0%	8.8%
Waxed bags	0.0%	1.4%
Mixed paper	0.0%	1.7%
Magazines, coated paper	0.0%	4.2%
Newspaper and inserts	1.1%	1.6%
Boxboard	2.0%	4.9%
Coated boxboard	5.3%	1.8%
Paper Subtotal	**10.5%**	**24.5%**
Plastic		
All Plastic bottles	1.6%	1.7%
Plastic bottles deposit	0.3%	0.1%
Plastic clamshells	0.0%	1.0%
Plastic tubs	0.7%	0.6%
Plastic film	7.5%	6.5%
All other plastic	6.0%	3.0%
Plastic Subtotal	**16.0%**	**12.9%**
Metal		
Ferrous cans	0.8%	0.8%
All other metal	0.6%	0.6%
Aluminum cans and foil	0.1%	0.8%
Aluminum cans - deposit	0.2%	0.0%
Metal Subtotal	**1.7%**	**2.2%**
Glass		
Glass bottles and jars	1.6%	2.1%
Glass bottles and jars - deposit	0.6%	0.2%
Glass Subtotal	**2.2%**	**2.3%**
Organic		
Food Waste/ All other organic	59.9%	22.5%
Dirty Paper	0.0%	19.9%
Organic Subtotal	**59.9%**	**42.4%**
Other		
Hazardous waste	0.0%	0.0%
Bulky waste	0.0%	0.0%
Construction waste	0.0%	1.4%
Textiles	0.0%	1.3%
All other waste	9.7%	13.0%
Other Waste Subtotal	**9.7%**	**15.7%**
Total	**100.0%**	**100.0%**

(1) In August, food waste was not seperated form other organic material such as compostable paper.

TABLE 11.
Grocery

Category	August	November
Paper		
Newspaper and inserts	13.4%	3.4%
Waxed occ	0.0%	3.1%
Corrugated and kraft bags	8.6%	11.9%
Mixed paper	0.2%	0.6%
Dirty paper	0.0%	1.2%
Magazines, coated paper	8.5%	0.1%
Boxboard	15.5%	1.0%
Coated boxboard	3.2%	2.9%
Paper Subtotal	**49.5%**	**24.2%**
Plastic		
All Plastic bottles	0.5%	0.8%
Plastic bottles deposit	0.1%	0.0%
Plastic clamshells	0.0%	1.2%
Plastic tubs	0.1%	0.2%
Plastic film	2.0%	4.4%
All other plastic	4.8%	2.9%
Plastic Subtotal	**7.5%**	**9.5%**
Metal		
Ferrous cans	0.2%	0.9%
All other ferrous	0.0%	1.0%
Aluminum cans	0.5%	0.2%
Aluminum cans - deposit	0.1%	0.0%
Metal Subtotal	**0.8%**	**2.1%**
Glass		
Glass bottles and jars	1.8%	0.8%
Glass bottles and jars - deposit	0.8%	0.8%
Glass Subtotal	**2.6%**	**1.6%**
Organic		
Food Waste	0.0%	48.0%
All other organic	39.4%	6.5%
Organic Subtotal	**39.4%**	**54.5%**
Other		
Bulky Waste	0.0%	0.0%
Construction waste	0.0%	0.9%
Hazardous Waste	0.0%	0.0%
Textiles	0.1%	0.4%
All other waste	0.2%	6.7%
Other Waste Subtotal	**0.2%**	**8.0%**
Total	**100.0%**	**100.0%**

(1) In August, food waste was not seperated form other organic material such as compostable paper.

TABLE 12.
Motels/Hotels

Category	November
Paper	
Newspaper and inserts	8.4%
Corrugated and kraft bags	3.2%
Mixed paper	5.5%
Dirty Paper	12.3%
Books	0.0%
Magazine and coated pap	7.9%
Boxboard	2.3%
Waxed/film boxboard	2.2%
Paper Subtotal	**41.9%**
Plastic	
Plastic bottles	2.5%
Plastic bottles-deposit	0.5%
Plastic clamshells	1.2%
Plastic tubs	0.4%
Plastic film	2.2%
All other plastic	3.0%
Plastic Subtotal	**9.7%**
Metal	
Ferrous cans	0.3%
All other ferrous	0.3%
Aluminum cans	0.4%
Aluminum cans - deposit	0.3%
Metal Subtotal	**1.4%**
Glass	
Glass bottles and jars	6.0%
Glass bottles - deposit	3.0%
Glass Subtotal	**9.0%**
Organic	
Leaf and yard waste	0.3%
Food/All other organic	20.1%
Organic Subtotal	**20.4%**
Other	
Hazardous waste	0.0%
Hazardous mercury	0.0%
Textiles	5.8%
Bulky waste	0.0%
Electronics	0.0%
Tires	0.0%
Construction waste	0.0%
All other waste	11.9%
Other Waste Subtotal	**17.6%**
Total	**100.0%**

Mixed Commercial

During the August sampling period DSM sorted 14 samples totaling 5,087 pounds of mixed commercial wastes. In addition to the average composition of the samples, a low and high range for each material category is included in Table 13 to illustrate the difficulty with waste composition sorting of mixed commercial loads[3]. As Table 13 indicates, there are wide variations in material composition depending on the types of generators in the sampled load, as well as the area of the load sampled. For example, the average composition of corrugated was 8.2 percent. Using this average one might conclude that there is still some corrugated left to recover, although not a significant amount. However, as the range shows, some commercial establishments are either not generating any corrugated, or recycling most of their corrugated, while other commercial establishments are generating and not recycling a significant amount of corrugated (at 35.9% of total waste).

Observations On The Commercial Waste Sorts

A review of commercial waste composition by generator indicates that potential remains to increase diversion of traditional paper and bottle and can recyclables. In addition, food wastes, which could potentially be diverted to separate organics management facilities, are prevalent in large quantities from some restaurant and grocery generators. Finally, as with residential waste, plastic film represents a significant, and apparently growing portion of the commercial waste stream.

Barriers to increased diversion of materials from commercial generators which must be overcome to realize this increased diversion include the following:

- In most cases it would be necessary for the commercial generator to keep additional materials separated to increase diversion. This requires space which may not be available or is costly (commercial space is typically leased on a square foot basis), as well as additional containers. In many cases these containers must also be leased from the haulers, creating a monthly charge which must be overcome by potential savings in avoided refuse pull and disposal charges.
- Separation and consolidation of materials also requires additional labor. For example, cardboard boxes must be emptied of contaminants such as foam packaging and coat hangers, and then broken down flat for storage. Typically, the labor that would be used is the lowest cost/highest turnover labor requiring supervision and training.
- Separate storage of organic wastes may increase odor and health issues at grocery and restaurant establishments which rely on their reputation of cleanliness. As a consequence, pick-up schedules, storage and container cleaning become significant cost issues.
- Plastic films are bulky to store and easily contaminated, in addition, many generators may receive a number of different film types that may be incompatible unless low-grade markets for the film are developed.

[3] Table 13 presents the mean value and high and low range of thirteen of the fourteen samples. The fourteenth sample represented a cleanout of an institution and therefore was excluded from the comparison.

TABLE 13.
Mixed Commercial
(August Only)

Category		Range	
	Average	**Low**	**High**
Paper			
Newspaper and inserts	2.7%	1.1%	7.4%
Corrugated and kraft bags	8.2%	1.6%	35.9%
White Office Paper	1.1%	0.0%	14.0%
Non-white mixed paper	4.3%	0.5%	15.7%
Dirty Paper	0.0%	0.0%	0.0%
Magazines, coated paper	1.5%	0.0%	9.0%
Boxboard	2.4%	0.0%	5.3%
Coated boxboard	0.5%	0.0%	2.9%
Books	0.0%	0.0%	0.0%
Paper Subtotal	**20.7%**	**9.4%**	**59.3%**
Plastic			
All Plastic bottles	2.1%	0.0%	5.0%
Plastic bottles deposit	0.1%	0.0%	0.3%
Plastic Film Clean	2.7%	0.2%	8.3%
Plastic Film Dirty	0.7%	0.0%	4.2%
All other plastic	4.1%	0.2%	18.1%
Plastic tubs	0.2%	0.0%	1.0%
Plastic Subtotal	**9.8%**	**3.0%**	**23.6%**
Metal			
Ferrous cans	1.2%	0.0%	3.9%
All other ferrous	3.7%	0.0%	24.1%
Aluminum cans and foil	0.2%	0.0%	0.7%
Aluminum cans - deposit	0.1%	0.0%	0.3%
Scrap metal	0.0%	0.0%	0.7%
Metal Subtotal	**5.3%**	**1.6%**	**24.1%**
Glass			
Glass bottles and jars	1.3%	0.0%	3.3%
Glass bottles and jars - deposit	0.2%	0.0%	1.2%
Glass Subtotal	**1.6%**	**0.0%**	**3.7%**
Organic			
Leaf and yard waste	0.1%	0.0%	1.2%
All other organic	36.4%	4.2%	51.8%
Organic Subtotal	**36.6%**	**4.2%**	**51.8%**
Other			
Hazardous waste	0.3%	0.0%	3.8%
Small appliances	1.0%	0.0%	6.4%
Electronics	4.0%	0.0%	40.3%
Construction waste	1.7%	0.0%	7.6%
Textiles	3.4%	0.0%	23.1%
Tires	0.0%	0.0%	0.0%
Clean wood	0.6%	0.0%	1.8%
All other waste	15.1%	3.7%	42.1%
Other Waste Subtotal	**26.1%**	**4.1%**	**59.4%**
Total	**100.0%**		

Solid waste districts interested in increasing commercial waste diversion must be prepared to work closely with private haulers and the business community to overcome these barriers.

Construction and Demolition Wastes

DSM observed a total of 50 C&D waste loads at the two sorting locations during the two weeks of sampling in August, 2001. Table 14 displays the compilation of these observations. The percentages in Table 14 were calculated by weighting the percentage *volume* estimate from each load observed by the weight of that load to account for differences between 100-yard trailers and small truckloads. It should be noted that the composition estimates were all made based on volume and not adjusted for the differences in material densities.

As shown in Table 14, wood waste made up between 33 and 54 percent of the total volume of the loads observed, with clean wood totaling between 17 and 32 percent by volume. Second to wood waste was asphalt shingles totaling between approximately 15 and 26 percent by volume.

The major difference between the loads at Waste USA and WSI was the amount of scrap metal in the loads (3 and 11 percent respectively). Part of the reason for the higher scrap metal quantities at WSI is that WSI is willing to remove the scrap metal after delivery on the tip floor. In addition, more furniture was found in the loads at WSI than in the loads at Waste USA. Some of the WSI loads would better be categorized as bulky waste even though it was designated as “construction waste”, as the load was a cleanout prior to a renovation job.

Other observations about the results include that hazardous wastes were found in very small quantities (less than 0.5 percent of the load by volume) in both locations. Asphalt, brick and concrete (ABC) waste was also found in very small quantities at both locations.

Finally, the all other C&D waste category was used as a catch-all for different wastes such as plastic compound buckets, plastic crates, nail boxes, non recyclable packaging, electronics, rugs, bedding, broken tools, bottles and cans and other municipal solid waste. However, most of this material that is currently recyclable was observed in very small quantities in each load.

TABLE 14.
Estimated Composition of C & D Waste, By Volume
(August Only)

Category	Percentage of Total Material by Volume[3]		
	Waste USA	**WSI**	**Average**
Painted and pressure treated wood	31.8%	17.2%	24.5%
Clean wood [1]	22.5%	16.0%	19.3%
Asphalt shingles	15.3%	26.1%	20.7%
Drywall	5.6%	4.2%	4.9%
Insulation	3.5%	3.5%	3.5%
ABC waste	0.2%	0.0%	0.1%
Corrugated cardboard	3.8%	1.9%	2.9%
Scrap metal	3.0%	11.0%	7.0%
Hazardous wastes	0.0%	0.1%	0.0%
Hazardous wastes w/ mercury	0.3%	0.1%	0.2%
Plastic Film	0.4%	0.2%	0.3%
Furniture (chairs/couches/matresses)	1.7%	6.5%	4.1%
Rugs	0.7%	0.3%	0.5%
Tiles, flooring	0.5%	0.4%	0.4%
All other C&D waste [2]	10.7%	12.4%	11.6%
TOTAL	**100.0%**	**100.0%**	**100.0%**

[1] Includes nails.

[2] Misc. waste that doesn't fit into any other categories.

[3] Volume based estimates made by observation only. Averages shown were weighted by load weight.

APPENDIX A

RESULTS OF INDIVIDUAL SORTS