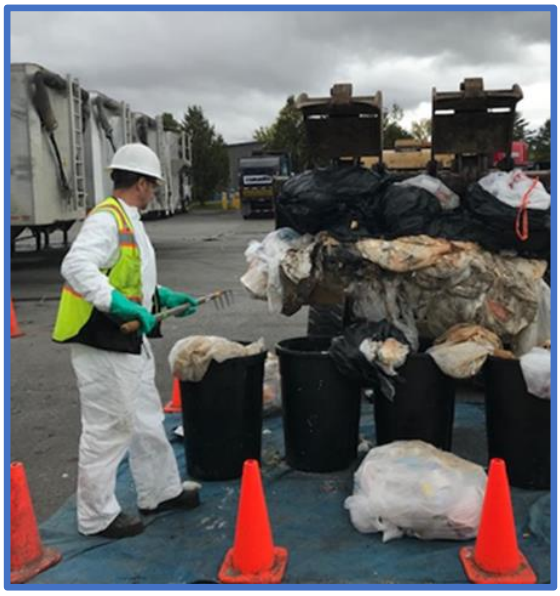

2018 VERMONT WASTE CHARACTERIZATION

Prepared for:

VERMONT DEPARTMENT OF ENVIRONMENTAL CONSERVATION, SOLID WASTE PROGRAM

Prepared by:

DSM ENVIRONMENTAL SERVICES, INC.
Resource Economists
Environmental Scientists

With support from:

MSW CONSULTANTS

Castleton Polling Institute

2018 Vermont Waste Characterization

FINAL REPORT | DECEMBER 14, 2018

REPORT TO THE:

Vermont Department of Environmental Conservation, Solid Waste Program

Prepared by:

DSM ENVIRONMENTAL SERVICES, INC.
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Executive Summary

DSM Environmental Services, Inc. (DSM), together with its' subcontractors MSW Consultants and the Castleton Polling Institute (Project Team) were contracted by the Vermont Department of Environmental Conservation (VT DEC) to conduct a comprehensive analysis of the composition of Mixed/Municipal Solid Waste (MSW) and Construction and Demolition (C&D) wastes generated in Vermont. In addition, VT DEC requested two additional surveys to assess both the amount of backyard composting of residential waste and the amount of "economic recycling" occurring in Vermont. Economic recycling consists primarily of large generators of recyclable materials who contract directly with a broker or end user to recycle their materials, bypassing materials recovery facilities who report directly to VT DEC and manage the majority of residential and commercial recyclables.

Sampling and hand sorting of residential and institutional/commercial/industrial (ICI) wastes represented the largest component of the analysis, and the results are graphically summarized below. Sampling and hand sorting of MSW was completed using the American Society of Testing Materials (ASTM) Test Method for Determination of the Composition of Unprocessed Municipal Solid Waste, Designation D 5231 – 92 (2016). This standard involves randomly selecting garbage trucks entering a landfill or transfer station that are hauling either residential or ICI waste, dumping the waste in a pile and randomly selecting a 200 to 250-pound sample from the pile which is brought to a sorting table and sorted into an agreed upon number of categories. This study included 77 material categories, although typically not all samples contain all 77 materials.

The results from each residential sample and each ICI sample sorted are averaged to calculate an average percent composition for residential MSW and for ICI MSW. This study sorted 181 samples (95 residential and 86 ICI) over the course of the spring and fall seasons.

This study also included a limited number of visual characterizations of construction and demolition (C&D) wastes. The C&D visual survey protocol followed published methods that have been successfully applied by the Project Team, although no universally recognized standard method exists for such visual surveys.

Gate Surveys to Determine Generator Source

Waste sorting results in an estimated percent composition for each waste stream. These estimates are then applied to the total tons of residential and ICI MSW disposed in the State to calculate tons disposed by material type for the residential and ICI sectors. However, the amount of residential waste compared to ICI waste is hard to determine based solely on the reports filed with VT DEC.

While VT DEC requires all transfer stations and the New England Waste Services of Vermont, Inc. (NEWS) landfill (Coventry, VT) to report quarterly on quantities disposed, the reports do not distinguish between residential and ICI waste, and often do not separately account for disposal of C&D wastes or bulky wastes (typically furniture and other large items generated during cleanouts of houses and businesses). Because hand sorting is not an efficient way to characterize C&D or bulky wastes, and because there are significant differences between residential and ICI wastes, gate surveys of drivers delivering waste to Vermont facilities were used to determine how much of Vermont's waste is residential versus ICI MSW, as well as how much is bulky waste compared with C&D waste.

DSM conducted 20 day of gate surveys at transfer stations and the NEWS (Coventry) landfill from April through July of 2018. These gate surveys were used to allocate the reported waste disposed in Vermont into five categories:

- Residential mixed solid waste (MSW);
- ICI MSW;
- C&D waste;
- Bulky wastes (residential or ICI source); and,
- Other wastes (e.g., MRF residue).

Table E.1 summarizes the results of the gate surveys performed in Vermont and the subsequent allocation of waste disposed. The gate survey data (*Allocation %*) was applied to total disposal from all reporting facilities except for BATS and Myers, which were not part of the gate surveys since they accept only C&D for processing.

Table E.1.
Final Allocation of Disposed Waste by Generator and Material Type

Type of Waste	Allocation (%)	Tons
Residential		
Bulky	5%	24,526
MSW	39%	196,110
Subtotal:	**44%**	220,636
ICI		
Bulky	1%	5,398
MSW	37%	185,251
Subtotal:	**38%**	190,649
C&D		
BATS & Myers (1)		22,888
All Other Facilities	16%	78,872
Subtotal:		101,760
Other Wastes (2)	2%	10,973
Total Waste (3):	**100%**	**501,130**
Total MSW, Excluding C&D:		**422,258**

(1) Tonnages are net of incoming materials later transferred to facilities included in the Gate Surveys.

(2) This tonnage includes MRF residues and other MSW that could not be classified as residential or ICI.

(3) Excludes C&D waste processed to remove recyclables at BATS and Myers.

Figures E-1 – E.3 provides snapshots of the different types of loads delivered for disposal to illustrate the difference between bulky wastes, C&D wastes and non-bulky MSW. The gate surveys identified the percentage of total deliveries (by weight) that were bulky wastes, C&D wastes, non-bulky residential MSW and non-bulky ICI MSW. Only non-bulky residential and ICI MSW were hand sorted.

Figure E.1.
Photograph of Bulky Waste Load Delivered

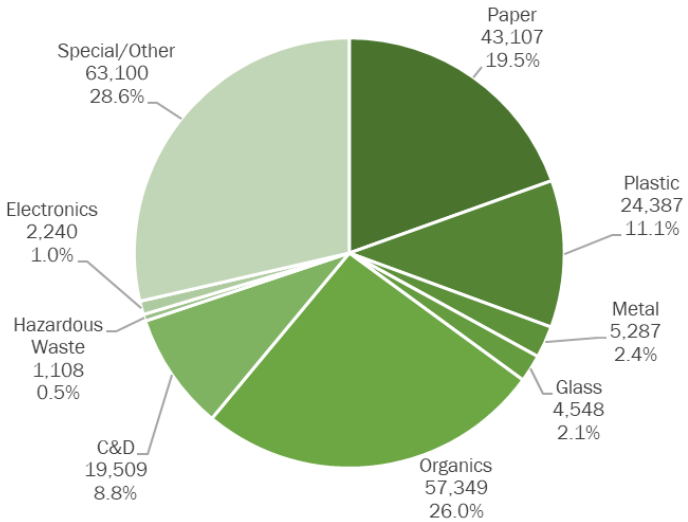
Figure E.2
Photograph of C&D Load Delivered

Figure E.3
Photograph of Sample Taken from ICI Load

Residential Waste Composition

Figure E.4 presents the aggregate composition of residential MSW, both on a percentage and tonnage basis. Figure E.4 includes 196,110 tons of residential waste allocated from the hand sort data plus 24,526 tons of bulky wastes added to the Special/Other category to be consistent with previous waste composition studies conducted for VT DEC. Note that the 19,509 tons of C&D waste are those C&D materials found mixed into the residential MSW loads from which samples taken, not C&D loads excluded from the gate surveys and hand sorting.

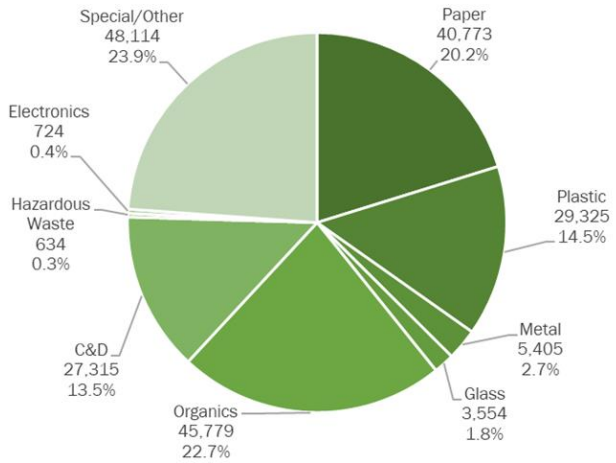
Figure E.4.
Composition of Residential MSW



ICI Waste Composition

Figure E.5 illustrates the aggregate composition of the 190,649 tons of ICI MSW disposed by Vermont businesses and institutions. This includes 185,251 tons of hand sorted ICI MSW along with 5,398 tons of bulky ICI MSW, and as with residential sampling, the C&D waste shown are those C&D materials mixed in with the ICI loads sampled.

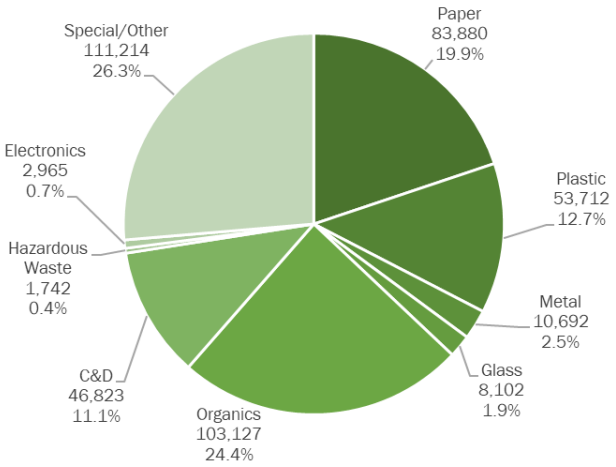
Figure E.5.
Composition of ICI MSW



Aggregate Composition

Figure E.6 presents the results of combining residential and ICI MSW, *adding in the 10,973 tons of Other MSW Waste from Table E.1*. This represents a complete view of Vermont MSW disposal, exclusive of C&D wastes.

Figure E.6.
Aggregated Composition of Vermont Waste



Materials Recovery Rates

Combining reports submitted to VT DEC by recycling facilities in Vermont (CY 2017), data on estimates of deposit container returns (2012), and date from the Economic Recycling survey conducted as part of this analysis; with data from the Residential and ICI waste composition analysis it is possible to calculate state-wide recycling material recovery rates for Vermont.

Table E.2 illustrates that the overall materials recovery rate is estimated at 72 percent, with recovery of fiber (paper) at 74 percent and containers (bottles and cans) at 67 percent.

Table E.2. Estimated State-Wide Recyclable Materials Recovery Rate (1)

Material	Total Recyclables		
	Fiber	*Containers*	*Total*
	(tons)	(tons)	(tons)
Disposed	33,124	18,137	51,261
Recycled	92,483	36,183	128,666
Recovery Rate (%):	74%	67%	72%

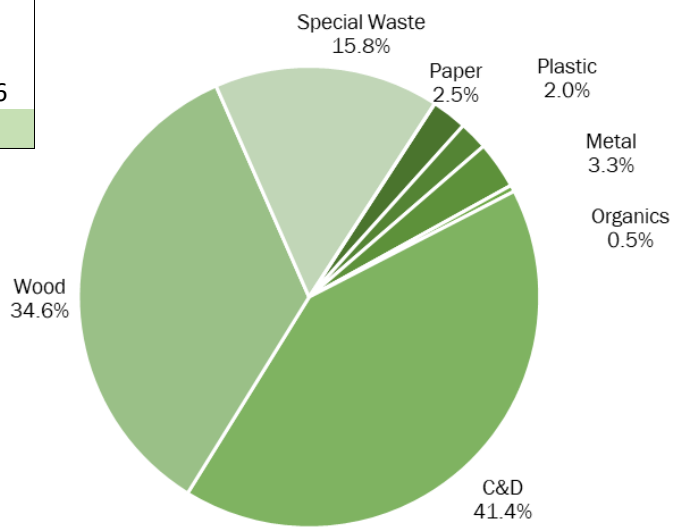
(1) Includes Economic Recycling estimate as referenced on the next page.

(2) Small quantities of recyclable paper and containers are disposed in C&D and bulky waste and are excluded from Table E.6.

Construction and Demolition Waste

DSM also carried out limited visual analysis of C&D wastes delivered to C&D processing facilities and to transfer and disposal facilities. Figure E.7 presents rough estimates of the composition, recognizing that the number of visual samples is relatively low resulting in very large confidence intervals. Detail on the C&D fraction can be found in Table 14 of the Report with the main component being roofing materials followed by gypsum board.

Figure E.7. Estimated Composition of C&D Wastes



Backyard Composting

The Castleton Polling Institute results indicate that roughly 27,600 tons (rounded) of food waste is diverted to composting and fed to animals or livestock in Vermont. Roughly 24,800 tons were diverted through backyard composting or animal feeding, with the remainder diverted to drop-off sites, or set out for curbside collection.

Given estimated food waste diversion of 27,600 ton with disposal of residential food waste at 40,776 tons, Vermont households are currently achieving a 40 percent diversion rate for residential food waste, primarily through backyard composting.[1]

Economic Recycling

DSM estimates that roughly 29,000 tons of materials are recycled by businesses using brokers or dealing directly with mills, over and above material recycled through Vermont's material recycling facilities (at 96,900 rounded tons). This estimate is included in the recovery rates shown in Table E.2.

Comparisons with Other States and Over Time

DSM and subcontractor MSW Consultants have recently conducted similar statewide waste composition studies for Connecticut (2015), Rhode Island (2015) and Delaware (2016). Because the Project Team and methodology is essentially the same for Vermont as for these other three states, the sampling and sorting protocol are also the same, making comparisons more reliable.

With respect to recyclable materials, Vermont falls squarely in the range of the other three states, except for the quantity of paper found in the ICI waste stream. The percentage of paper found in Vermont's ICI MSW is lower, falling slightly below the low end of the confidence interval range for Delaware and well below Rhode Island and Connecticut.

With respect to food waste, Vermont falls below Connecticut and Delaware but above Rhode Island in terms of food waste disposal per capita both in the residential sector and overall.[2]

Comparing Vermont's 2002 and 2012 waste characterization results against this 2018 analysis yields the following broad conclusions.

- There is a noticeable decrease in the weight of paper recyclables found in the residential waste stream, starting with an estimated 16.7% of total waste in 2002 and falling to 8.6% in 2017. Tonnage data were not available for 2002 but the estimated decrease in tons of recyclable paper disposed between 2012 and 2017 is significant.
- There is also a significant decline in recyclable paper disposed in the ICI sector between 2012 and 2017.

[1] *See Table 7 for detail on estimated food waste tonnages found in the residential waste stream.*

[2] *The impact of Vermont's seasonal residents was not part of this comparison.*

- The trend of increasing plastics disposed continues, both in Vermont and elsewhere. Because most plastic is so light weight, weight-based sampling continues to show plastic as less of a material disposed when compared to heavier paper and food waste. However, if one were to convert to a volume-based estimate, it is likely that plastic would be the largest single material disposed in the landfill.[3]
- The estimated amount of residential food waste disposed in 2017 is not significantly different from 2012, but with less residential MSW being disposed overall (by weight, in 2017), denser food waste becomes a higher percentage of MSW disposal. This is a growing trend as other dense materials are removed from the stream (paper, metals, C&D and other wastes) leaving behind food waste as one of the denser materials still present in large quantities.
- The significant estimated increase in ICI food waste is due to both an increase in estimated ICI waste disposed (roughly 20,000 tons) and a decrease in other dense materials found in the ICI waste stream, also making food waste a greater percentage by weight in the overall ICI MSW stream.

[3] *DSM is not aware of any recent studies that have documented the volume of materials in landfills, and therefore is basing this conclusion on relatively old data available to DSM from a South African study on material densities and the impact on landfills.*

Introduction

In accordance with DSM Environmental Services' (DSM) Contract for Services #35168, this Final Report summarizes all the data DSM and Sub-Contractors, MSW Consultants and the Castleton Polling Institute (CPI), have collected and analyzed over the course of this project.

Key tasks carried out under this contract included the following.

- A ***statewide waste characterization study*** consisting of:
    a) Twenty days of ***gate surveys*** designed to allocate solid waste disposal into Residential municipal/mixed solid waste (MSW), Industrial/Commercial/Institutional (ICI) MSW, Bulky wastes, and Construction and Demolition (C&D) wastes;
    b) Four weeks (181 samples) of ***hand sorting of residential and ICI MSW*** at four representative facilities across the State over two seasons; and,
    c) Limited ***visual observations of the composition of C&D waste*** delivered to the two C&D transfer/processing facilities and to transfer stations and the NEWS (Coventry) landfill.
- A ***home composting survey*** conducted by the Castleton Polling Institute designed to estimate the percent of Vermont households who compost some portion of their food waste.
- An ***economic recycling survey*** of businesses that have arranged for recycling due to favorable business economics, with materials delivered directly to end markets or brokers, and consequently do not have their tonnage captured within the state's reporting MRFs.

DSM served as the Project Manager and carried out the gate surveys, the visual characterizations of C&D wastes and the economic recycling survey while MSW Consultants managed and carried out the hand sorting of MSW. The Castleton Polling Institute developed and carried out the home composting survey with guidance from DSM.

This report summarizes the results of the surveys and waste sorting and provides estimates of the composition of residential and ICI MSW in Vermont. It also estimates the quantity of residential and ICI MSW, bulky wastes, and C&D waste disposed by Vermonters.

Finally, the results of the home composting survey and the economic recycling survey help to better define diversion activity in Vermont, and combined with the waste composition data, help to track current diversion and illustrate the opportunities for additional diversion.

I. Gate Surveys

Introduction

Waste characterization studies tabulate the results of manual sorting of representative samples of residential and ICI waste in percentages, by weight, for each material type included as a sort category. The next step is to apply those percentages to reported tons to understand how much (by weight) of each material type is typically found in the study region's MSW stream, and more specifically how much is found in residential versus ICI MSW.

There are two main reasons to have a defensible estimate of the total quantities of residential versus ICI MSW. First, residential MSW composition is significantly different from ICI MSW, and therefore the tons allocated to each generator category must be a reasonable estimate of total MSW. And second, not all wastes reported as MSW are either residential or ICI waste, and therefore without adjusting down for the presence of wastes which were not hand sorted – mainly bulky wastes and C&D materials – materials found in residential and ICI waste will be inflated.

While Vermont DEC requires all transfer stations and landfills to report quarterly on total quantities received of MSW (and of C&D), they do not require the operators to differentiate between residential and ICI waste. In some cases, the operator is unable to differentiate because loads are mixed, with trucks collecting residential and ICI waste along the same route. In addition, bulky wastes and C&D wastes are often delivered to the same facility and may or may not be correctly coded. This is important because the waste characterization sampling and sorting targets residential and ICI MSW, and typically excludes loads that are primarily C&D wastes or bulky wastes. This is because it is extremely difficult to obtain representative 200-pound samples of C&D and bulky wastes, which are typically characterized by a different methodology.

For this reason, the Project Team conducted 20 days of gate surveys at representative transfer stations throughout Vermont and the NEWS landfill, with the results used to allocate the total annual disposed MSW (CY 2017 data, adjusted[4]) into categories for residential, ICI, C&D and bulky wastes. The allocated tons of residential and ICI waste can then be multiplied by the material percentages determined by the MSW waste sampling and sorting to estimate the total tons of each material type found in residential and ICI wastes.

Surveys Targeted and Completed

DSM performed gate surveys at representative transfer stations (and the NEWS landfill) from March through July 2018. For each survey, the refuse truck driver was asked to answer questions about the contents and source of the load delivered. This included providing information on the source of the waste (households, ICI, construction site/C&D, or clean out/bulky wastes) including distinguishing apartments, multi-family dwellings and condominiums as residential waste (as opposed to commercial waste which it is often referred to in the industry). The enumerator also asked the driver to estimate the percentage of the route/load originating from each generator class if the load was mixed, and in some cases watched the truck tip the load to view the contents if the driver did not know the load's source.

[4] Because of adjustments made for FY 2018 C&D processing and disposal, CY 2017 disposal figures used in this report may not exactly match those found in the VT DEC CY 2017 Diversion and Disposal Report.

Finally, DSM recorded the time, truck number and truck type, and also collected a weight for each load surveyed that could be used to compile the final data.

The number of survey days targeted for each facility are shown in Table 1 and were based on facility tonnage report data for CY 2016 (the most recent available at the start of the Project), which were analyzed by DSM to ensure broad representation across the State. Table 1 also aggregates the total tonnage surveyed at each of the targeted facilities (Gate Survey Tonnage) based on scale data obtained for all samples surveyed, and the total days of surveying completed at each location.

Table 1. Survey Locations, Number of Days Targeted and Completed, and Tons of Waste Surveyed

Region	FACILITIES	Targeted Survey Days	Gate Survey Tonnage	2016 MSW Deliveries	Completed Survey Days
CSWD	All Cycle	4	867	94,023	4
Central	CV Transfer Station	3	323	48,670	3
CSWD	Burlington Transfer Station (1)	2	48	28,192	2
NEK	NEWS Direct	2	156	29,745	2
Rutland	RCSWD Gleason Road Transfer Station	2	221	26,368	2
Addison	Addison	2	142	21,515	2
Windham	Brattleboro Salvage	1	75	28,215	1
NW	Highgate	1	86	24,179	1
SW	TAM	1	66	19,908	1
Lammoille	Hyde Park	1	86	17,114	1
SW	Manchester Transfer Station	1	7	9,409	1
Total		**20**	**2,076**	**347,337**	**20**

(1) BATS is now C&D only, although some non-C&D is still delivered there

In some cases, such as roll-off deliveries from municipal transfer stations, the driver did not know the source of the waste. Therefore, after the gate surveys, DSM followed up with some municipal transfer station operators to obtain an estimate of the percentage of residential versus ICI waste that might be delivered to that municipal transfer station in order to properly record the sample data. The same was done for mixed loads of bulky and C&D delivered in roll-offs from municipal transfer stations.

Adjustments to Reflect Proportion of Annual Disposal by Facility

Table 2 utilizes the most recent reported disposal data (which was 2017, and available after the surveys were performed) to compare the percent of surveyed tons by facility to the percent of annual tons disposed through the surveyed facilities. As illustrated by Table 2, because of the high volume of MSW delivered to the All Cycle transfer station during the surveys, the results of the All Cycle surveys, if not adjusted, would distort the Statewide results by weighting All Cycle's data at 43.1% instead of adjusting down to reflect the lower annual throughput when compared to each of the other surveyed facilities. Therefore, DSM weighted the results for All Cycle to more accurately reflect the actual annual tonnage received over the course of a year which better portrays Vermont's waste stream (See last column, Percent of Total Annual, in Table 2).

Table 2. Comparison of Surveyed Tonnage with Annual Throughput

Facility	Total Tons Observed	Percent of Total Observed	Total Annual Tons Reported (2017)	Percent of Total Annual
All Cycle	867	43.1%	103,201	26.8%
CV	323	16.0%	50,082	13.0%
Rutland	221	11.0%	31,845	8.3%
Brattleboro	75	3.7%	28,215	7.3%
TAM	66	3.3%	21,847	5.7%
Addison	142	7.0%	29,862	7.8%
NEWS Direct	156	7.7%	29,745	7.7%
Manchester	7	0.4%	9,409	2.4%
Hyde Park	22	1.1%	17,114	4.4%
High Gate	86	4.3%	24,179	6.3%
BATS	48	2.4%	39,560	10.3%
Total	2,012	100%	385,059	100.0%

Annual Reporting to Vermont DEC

VT DEC provided DSM with the most recent annual data (CY 2017) on deliveries to Vermont's transfer stations and landfills, and their aggregated data on Vermont generated solid waste disposal. Calendar Year 2017 data were used, with the exception of the Burlington Area Transfer Station and the Meyers C&D processing facility, where the last two quarters of 2017 and the first two quarters of 2018 were used to better understand material flow closer to the same time period when the waste characterization was being performed.

Adjustments were made to the CY 2017 data to create final totals for MSW subject to the gate survey data. These totals were multiplied by the average of the survey data for the following categories of waste:

- Residential MSW;
- ICI MSW;
- C&D Waste (excluding Meyers and BATS material that left the State or was processed for recycling or beneficial use); and,
- Bulky Waste, which was classified as residential or ICI bulky waste.

The results are reported in Table 3 and represent DSM's recommendations for allocating total annual Vermont tons disposed.[5]

As illustrated by Table 3, 196,110 tons of residential MSW and 185,251 tons of ICI MSW were disposed in 2017. An additional 24,526 tons and 5,398 tons of residential and ICI bulky wastes respectively were also disposed, along with 10,973 tons of other wastes (e.g., MRF residue), resulting in total MSW disposal of 422,258 tons disposed, or 3.7 pounds per capita per day.

[5] Ideally waste would be classified accurately as C&D or MSW in the quarterly reports.

Finally, 78,872 tons of C&D waste were disposed in 2017, and 22,888 tons of C&D were reported processed at the Meyers processing facility and the Casella/BATS transfer station during FY 2018. This results in total C&D generation of 101,760 tons in 2017, or 0.9 pounds per capita per day. Note that an estimated 17,000 tons (rounded) of the C&D processed was diverted for recycling, leaving roughly .75 pounds per capita of C&D waste disposed for a total waste disposal rate of 4.4 pounds per capita including C&D waste.

Table 3. Proposed Allocation of 2017 Tons Disposed by Material Type

Type of Waste	Allocation (%)	Tons
Residential MSW		
Bulky	5%	24,526
All Other	39%	196,110
Subtotal:	**44%**	220,636
ICI MSW		
Bulky	1%	5,398
All Other	37%	185,251
Subtotal:	**38%**	190,649
C&D		
BATS & Myers (1)		22,888
All Other Facilities	16%	78,872
Subtotal:		101,760
Other Waste., MSW (2)	2%	10,973
Total Waste (3):	**100%**	**501,130**
Total MSW:		**422,258**

(1) Tonnages are net of incoming materials later transferred to facilities included in the Gate Surveys.
(2) This tonnage includes MRF residues and other MSW that could not be classified as residential or ICI.
(3) Excludes C&D waste processed to remove recyclables at BATS and Myers.

Based on the results of the gate surveys and the allocations shown in Table 3, the percentages derived from the two seasons of sorting of residential and ICI wastes were multiplied by 196,110 tons of residential MSW and 185,251 tons of ICI MSW, respectively.

Bulky wastes (which were roughly 6% of deliveries) and C&D wastes (estimated at 16% delivered to transfer stations and the landfill) are excluded from the hand sorting data, although DSM has estimated the composition of C&D waste based on limited visual surveys carried out as part of this study as discussed below.

It should be noted that the allocation of 39 percent residential MSW and 37 percent ICI MSW is significantly different from the 60 percent residential and 40 percent ICI MSW allocation used in the 2012 waste characterization report. This is because there were insufficient resources in 2012 to conduct gate surveys, so all the reported MSW was allocated roughly to residential and ICI waste. For this reason, it is not recommended that readers of this report compare tonnages by material type, instead the comparison should be based on the percent composition between the two reports.

II: Hand Sorting of MSW

For the first season, hand sorting of residential and ICI waste was carried out at the Gleason Road Transfer Station in Rutland the week April 2nd and at Triple T Trucking's Transfer Station in Brattleboro the week of April 9th. Two more weeks of hand sorting were carried out at the All Cycle Transfer Station in Williston the week of October 8th and at the NEWS/Coventry Landfill the week of October 15th. These locations and dates were selected to best represent Vermont's waste stream over the course of an average year.[6]

Selection of Samples

The overall goal of the Project's waste sampling was to hand sort 45 representative samples of MSW each of the four weeks of sampling, for a total of 180 samples over the course of the study. Because residential MSW is different from ICI MSW, the secondary goal was to only sample loads that were identified as either "residential" or "ICI". However, because trucks delivering MSW to transfer stations or landfills in Vermont often contain a mix of residential and ICI MSW, the definition agreed on in the Study Design was as follows:

- **Residential** – MSW generated in Vermont and brought to VT DEC permitted facilities in which 80 percent or more of the waste is from single-family and/or multifamily (or condominiums) residential sources. Loads from large transfer trailers entering the facility were not sampled because the generator types could not be determined. However, smaller loads (30 to 40-yard enclosed roll-offs) from several transfer stations accepting primarily residential waste were sampled when they arrived at the sampling location if the driver reported that the drop-off location served primarily households.
- **Institutional/Commercial/Industrial (ICI)** – MSW generated in Vermont and brought to VT DEC permitted facilities in which 80% or more of the waste was from institutional, commercial, or industrial sources. This sector excluded loads that were primarily Construction and Demolition debris or Bulky wastes. Vehicles chosen for sampling in the ICI sector included Compacted Drop Boxes where the generator could be identified**,** Packer Trucks, and in some cases, haulers using other truck types.
- **Unacceptable Loads** – Loads originating from outside of Vermont were omitted from the sampling along with loads that contained less than 80% of either residential or ICI wastes. However, in a few cases where the majority of loads entering a facility were mixed residential and commercial and it was not possible to obtain a sufficient number of samples of residential or ICI loads from trucks with over 80% of the designated sector, a decision was made by the Field Supervisor, after discussions with the truck driver, to sample from the portion of the load which the driver indicated was primarily residential or ICI waste.

[6] While ideally, additional facilities would be chosen for sorting, the logistics and costs related to mobilizing the sort crews to each location made adding additional facilities infeasible.

Allocation of Samples by Site, Sector, and Season

The study design called for collecting representative samples and hand-sorting a total of 180 samples of residential and ICI waste, each weighing 200 to 250 pounds. The intent was to split the samples evenly between the spring and fall seasons and between residential and ICI samples as shown in Table 4.

Table 4. Initial Allocation of Hand Sort Samples

Facility	Number of Samples
Spring Season	
Facility 1	45
Facility 2	45
Fall Season	
Facility 3	45
Facility 4	45
Total:	**180**

Ultimately, due to lack of truck traffic at several of the facilities sampled, the Project Team found it necessary to increase the number of samples collected in the Fall at the All Cycle Transfer Station to ensure that the total sample size of 180 was met. In addition, for the same reason, slightly more residential samples were taken than ICI samples as illustrated by the final sample count shown in Table 5.

Table 5. Final Allocation of Hand Sort Samples

Facility	# of Residential Samples	# of Commercial Samples	# of Aggregate MSW Samples
Spring Season			
Rutland	22	23	45
Brattleboro	20	19	39
Fall Season			
All Cycle	27	28	55
NEWS Direct	26	16	42
Total	**95**	**86**	**181**

In addition to hand sorting of MSW samples, 59 loads of C&D waste were visually characterized over the course of the two seasons. The number of loads visually characterized was not specified in the Study Design but was instead dependent on the number of hours allocated to C&D visual characterization and the number of loads that came in during those hours when DSM professionals were onsite.

Vehicle Selection for MSW Sampling

The Field Supervisor attempted to follow a systematic selection procedure, as outlined in the Study Design, to identify residential and ICI waste vehicles for sampling by establishing a sampling interval at each facility. The sampling interval was determined by dividing the total expected number of loads for each sector likely to arrive at the facility on the scheduled day – based on questions asked of each facility in the planning phase of the study -- by the number of samples required each day. The resulting number is the sampling frequency, which determines whether every third vehicle, every sixth vehicle, or every 20th vehicle is selected for sampling. This strategy is referred to as "selecting every nth vehicle" within a waste sector.

Vehicles entering the facility that met the definition of the nth vehicle were surveyed by the Field Supervisor to determine if they were eligible for sampling. In order for a vehicle to be eligible for sampling, the load had to fit within the residential or ICI definitions. If the load was selected for sampling, then the Field Supervisor collected data regarding the vehicle type and waste type and identifying information for use in obtaining a net weight from each selected vehicle from the scale house.

There were five instances where the nth vehicle approach for selecting a vehicle for sampling was modified:

(1) On the day of sampling and sorting, if the number of loads expected to arrive at the facility was less than previously anticipated, the sampling frequency was shortened and a new "nth vehicle" selection strategy calculated and followed;
(2) If the nth residential vehicle selected was found to contain over 20% of ICI waste, the next load of residential waste (nth + 1) delivered was taken as a replacement;
(3) If the nth commercial vehicle selected was found to contain over 20% residential waste, the next load (nth + 1) delivered of ICI waste was taken as a replacement;
(4) If the sort crew had completed sorting of all available stored samples and was set up and ready for the next sort, the Field Supervisor was allowed to take the next available residential or ICI load in place of the nth vehicle to keep the sort crew busy; and,
(5) In the event that the waste was not from Vermont.

It is important to note here that because of the small amount of waste delivered to most Vermont transfer stations, and direct hauled to the NEWS landfill, the exceptions listed above occurred often as part of this waste characterization. As a consequence, on many days the Field Supervisor took every truck that met the 80 percent criteria to try to ensure that the required sample target could be met over the course of the day and week.

The Field Supervisor obtained and recorded the following information on the *Vehicle Selection Form* for each vehicle that was selected for sampling:

- Waste sector – Residential or ICI;
- Vehicle type -- Compactor, Transfer Vehicle, Packer Truck or Other Type;
- Date and Time of Day;
- Truck Identification information (Hauler License or Plate Number); and,
- Net weight of the load (obtained from the scale house using the truck identification information).

The Crew Chief then recorded the date and time, sample number, and facility location, and noted on the *Field Data Sheet* any unusual circumstances associated with the load or the sample.

Sample Collection from The Selected Loads

Once the selected truck had dumped the load on the tipping floor or landfill face the Field Supervisor would direct an operator of the facility to take a sample from the load using either a skid steer or front loader. Just as with the random selection of each truck for sampling, the sample point in the load was randomly selected to assure that the Field Supervisor did not bias the sample by selecting only easy to sort waste material. A bucket load was taken from that sample point and then brought to the hand sorting location and at least 200 pounds were raked out of the bucket into 32-gallon trash cans, if the material fit, or dumped next to the cans if the material did not fit.

Each full trash can was weighed, and additional trash cans filled, until the weight equaled between 200 and 250 pounds.

Figure 1. Carts Waiting to Be Filled, NEWS; and, Obtaining Sample, Triple T, Brattleboro

The trash cans containing the sample were then set aside with a placard indicating the sample number and type until the sort team was ready for hand sorting the sample.

Hand Sorting Protocol

Each sample was hand sorted for separation into up to 77 categories, as summarized in Table 6, below[7]. It should be noted that although there were 77 possible primary and secondary sort categories where waste materials might be classified it was often the case that not all categories would be found in each sample.

The Field Supervisor and Crew Chief (both from MSW Consultants), and the sort crew consisting of four trained sorters (temporary laborers) would then sort the sample into the labeled bins for weighing.

Once the hand sorting of the entire sample was complete, the Crew Chief would weigh each bin and record the net weight of the sample on the electronic data form. When all weighing was complete, the sorting table would be cleared, and the next sample dumped onto the table for sorting.

Note that as illustrated by Table 6, the Crew Chief would typically save certain bins, for which a sub-sort into a finer level of detail was necessary. This often occurred after the primary sort was completed because this was a more efficient way to sort small quantities of items, often requiring special expertise (and extra time) to identify – for example sorting of bottles into non-deposit, deposit (BB) and expanded (EBB) bottle bill bottles and cans.[8]

Figure 2. Sorting, All Cycle and Triple T Trucking Transfer Stations

[7] Appendix A contains the complete material definitions for each category.

[8] The current bottle bill applies a deposit only on carbonated beverages. An expanded bottle bill would apply the deposit to non-carbonated beverages – water, fruit juices, wine, etc.

Table 6. Hand Sort Categories

	No.	Category	Sub-Sort		
PAPER	1	Newsprint			
	2	High Grade Office Paper			
	3	OCC (Old Corrugated Cardboard)			
	4	Magazines/Catalogs			
	5	Mixed Recyclable Paper			
	6	Boxboard (chipboard)			
	7	Books			
	8	Polycoated / Aseptic Containers			
	9	Compostable Paper			
	10	Non-Recyclable R/C Paper			
PLASTIC	11	#1 PET Bottles	BB	EBB	
	12	#1PET Food and Dairy Bottles and Jars			
	13	#2 HDPE bottles	BB	EBB	
	14	HDPE Food and Dairy			
	15	# 3 - 7 Bottles	BB	EBB	None
	16	Plastic Cups, Tubs and Lids			
	17	Bulky Rigids >1 Gallons			
	18	Thermoforms			
	19	Plastic Pouches			
	20	Film, Retail Bags			
	21	Film, ICI Wrap			
	22	Film, Garbage			
	23	Film, Other			
	25	Other Plastic			
METAL	26	Aluminum Beverage Cans	BB	EBB	
	27	Aluminum Foil, Pans & Food Cans			
	28	Ferrous Containers			
	29	Other Ferrous			
	30	Other Non-Ferrous			
GLASS	31	Glass Beverage Bottles	BB	EBB	None
	32	Food and Dairy Glass			
	33	Plate Glass			
	34	Other Glass			
ORGANICS	35	Food Waste	Packed	Unpacked	
	36	Leaves, Grass & Brush	<1"	>1"	
	37	Pet Waste			
	38	Other Organics			
ELECTRONICS	39	CED CRT's			
	40	CED Televisions & Monitors, non CRT			
	41	CED Desktop & Laptop Computers			
	42	CED Computer Peripherals/Printers			
	43	Banned, non-CED electronics			
	44	Small Appliances			
HHW	45	Paint			
	46	Batteries	Primary	Recharge	
	47	Mercury Containing Products	Thermos	Lamps	Other
	48	Other			
C&D	49	Drywall/Gypsum Board			
	50	C&D Metal			
	51	Asphalt Shingles			
	52	Plywood			
	53	Oriented Strand Board			
	54	Asphalt Brick and Concrete			
	55	Painted and Treated Wood			
	56	Clean Wood			
	57	Other C&D			
SPECIAL/OTHER	58	Textiles/Leather			
	59	Rubber			
	60	Carpet/Padding			
	61	Diapers/Sanitary Products			
	62	Furniture/Bulky Items			
	63	Tires			
	64	Fines/Dirt/Mixed Residue			
	65	All Other Wastes, Not Categorized			
Sorts	65			9	3

III. Hand Sort Results

Residential Waste

Table 7 below presents the results of the residential hand sort data.

Table 7. Composition of Residential MSW, Vermont, 2018[9]

Material	Estimated Percent	+ / -	Estimated Tons	Material	Estimated Percent	+ / -	Estimated Tons
Paper	**22.0%**	**1.9%**	**43,107**	**Organics**	**29.2%**	**2.1%**	**57,349**
Newsprint	1.5%	0.5%	2,937	Food Waste - Contained in Packaging	8.6%	1.0%	16,863
High Grade Office Paper	0.3%	0.1%	549	Food Waste - Loose	12.2%	1.6%	23,913
OCC (Old Corrugated Cardboard)	2.5%	0.9%	4,886	Leaves/Grass/Brush >1"	0.1%	0.3%	110
Magazines/Catalogs	1.3%	0.4%	2,547	Leaves/Grass/Brush <1"	1.4%	1.2%	2,741
Mixed Recyclable Paper	1.6%	0.6%	3,205	Pet Waste	4.9%	1.0%	9,515
Boxboard (chipboard)	1.4%	0.2%	2,798	Other Organics	2.1%	0.8%	4,208
Books	0.6%	0.4%	1,128				
Polycoated / Aseptic Containers	0.3%	0.1%	631	**Metal**	**2.7%**	**0.4%**	**5,287**
Compostable Paper	10.7%	0.9%	20,888	Aluminum Beverage Cans	0.2%	0.1%	463
Non-Recyclable Paper	1.8%	0.4%	3,538	Aluminum Foil, Pans & Food Cans	0.5%	0.1%	907
				Ferrous Containers	0.7%	0.1%	1,286
Plastic	**12.4%**	**0.9%**	**24,387**	Other Ferrous	0.9%	0.3%	1,726
#1 PET Bottles	0.7%	0.1%	1,276	Other Non-Ferrous	0.5%	0.2%	905
#1 PET Food and Dairy Bottles and Jars	0.3%	0.0%	556				
#2 HDPE Bottles	0.2%	0.1%	380	**Electronics**	**1.1%**	**1.0%**	**2,240**
#2 HDPE Food and Dairy	0.4%	0.1%	787	CED CRT's	0.3%	1.4%	576
#3 - #7 Bottles	0.1%	0.0%	238	CED Televisions & Monitors, non-CRT	0.3%	0.0%	626
Plastic Cups, Tubs and Lids	1.0%	0.1%	2,002	CED Desktop & Laptop Computers	0.0%	0.2%	57
Bulky Rigid Plastics > 1 Gallon	1.0%	0.7%	1,942	CED Computer Peripherals/Printers	0.0%	0.1%	23
Plastic Thermoforms	0.5%	0.1%	937	Banned, Non-CED electronics	0.1%	0.1%	262
Plastic Film Pouches	0.1%	0.0%	100	Small Appliances	0.4%	0.4%	697
Film - Retail Bags	0.8%	0.1%	1,622				
Film - ICI Wrap	0.4%	0.2%	773	**C&D**	**9.9%**	**2.2%**	**19,509**
Film - Garbage Bags	1.9%	0.3%	3,702	Drywall/Gypsum Board	0.4%	1.0%	764
Film - Other	2.8%	0.3%	5,476	C & D Metal	0.0%	0.4%	82
Other Plastic	2.3%	0.4%	4,595	Asphalt Shingles	0.8%	1.8%	1,656
				Plywood	0.4%	1.3%	783
Glass	**2.3%**	**0.4%**	**4,548**	Oriented Strand Board	0.0%	0.0%	1
Glass Beverage Bottles	1.0%	0.2%	1,904	Asphalt, Brick and Concrete	0.1%	0.0%	126
Food and Dairy Glass	0.6%	0.1%	1,128	Wood - Painted and Treated	3.2%	0.8%	6,294
Plate Glass	0.1%	0.5%	242	Wood - Clean	1.5%	0.8%	3,001
Other Glass	0.7%	0.3%	1,275	Other C & D	3.5%	1.5%	6,801
Special/Other	**19.7%**	**2.0%**	**38,574**	**Hazardous Waste**	**0.6%**	**0.3%**	**1,108**
Textiles and Leather	6.1%	1.0%	11,867	Paint	0.2%	0.9%	357
Rubber	0.8%	0.3%	1,575	Batteries (Primary)	0.1%	0.0%	198
Carpet and Carpet Padding	1.7%	0.9%	3,281	Batteries (Rechargeable)	0.0%	0.0%	4
Diapers/Sanitary Products	5.2%	1.0%	10,212	Mercury Thermostats/Thermometers	0.0%	0.0%	0
Furniture/Bulky Items	1.6%	4.1%	3,206	Mercury Lamps	0.0%	0.0%	14
Tires	0.4%	0.0%	792	Mercury - Other	0.0%	0.0%	2
Fines/Dirt/Mixed Residue	2.0%	0.6%	4,007	Other HHW	0.3%	0.1%	533
All Other Wastes Not Elsewhere Categorized	1.9%	0.7%	3,635				
				Grand Total	**100%**		**196,110**
				Sample Count	**95**		

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

[9] Note that while primary batteries were included under Hazardous Waste, they are in fact not classified as hazardous waste.

Table 7 presents each material type as an average percent composition of the residential samples, with the corresponding confidence interval (at a 90 percent confidence interval) and then shows the estimated tons which are calculated by multiplying the average percent times 196,110 tons of residential MSW as determined by the Gate Surveys (see above).

As illustrated, and is typically the case, Organics and Paper are the two largest categories, by weight, at 29.2 and 22 percent respectively. Food Waste (packaged and loose) is the largest category of organic waste, at 20.8 percent of all residential waste, or an estimated 40,766 tons. And "Compostable Paper" is the largest category of paper, at 10.7 percent, or an estimated 20,888 tons. It should be noted here, however that just because compostable paper could theoretically serve as a source of carbon for industrial composting facilities, most of these facilities do not accept much of this dirty paper because of contaminants inherent in loads of dirty paper.

Conversely, Old Corrugated Containers (OCC) represent the next largest quantity of paper, and most of this OCC is acceptable in curbside and drop-off recycling programs. This is a category that continues to grow in the residential waste stream because of on-line shopping (the "Amazon Effect"). However the percentage found in Vermont's residential stream is relatively low at 2.5 percent.

Residential Sub-Sort

Table 8 presents the results of the sub-sort of bottles and cans associated with the current bottle bill and a potential expanded bottle bill. As illustrated, the largest impact associated with an expanded bottle bill would be on PET containers and glass bottles associated with all the non-carbonated beverages sold in those two material types.

Table 8. Sub-Sort of Potential Bottle Bill Material

Material Subsorts	Absolute Pct	Relative Pct	Tons
#1 PET Bottles	**0.9%**	**100.0%**	**1,832**
#1 PET Bottles BB	0.2%	18.5%	340
#1 PET Bottles EBB	0.4%	42.4%	777
#1 PET Bottles None	0.1%	8.7%	160
#1 PET Food and Dairy Bottles and Jars	0.3%	30.3%	556
#2 HDPE Bottles	**0.6%**	**100.0%**	**1,167**
#2 HDPE Bottles BB	0.0%	0.0%	-
#2 HDPE Bottles EBB	0.1%	10.9%	127
#2 HDPE Bottles None	0.1%	21.7%	253
#2 HDPE Food and Dairy	0.4%	67.4%	787
#3-#7 Bottles	**0.1%**	**100.0%**	**238**
#3 - #7 Bottles BB	0.0%	3.6%	9
#3 - #7 Bottles EBB	0.0%	5.1%	12
#3 - #7 Bottles None	0.1%	91.2%	217
Glass Beverage Bottles	**1.5%**	**100.0%**	**3,031**
Glass Beverage Bottles BB	0.3%	21.3%	645
Glass Beverage Bottles EBB	0.6%	35.6%	1,080
Glass Beverage Bottles None	0.1%	5.9%	179
Food and Dairy Glass	0.6%	37.2%	1,128
Aluminum Beverage Cans	**0.7%**	**100.0%**	**1,370**
Aluminum Beverage Cans BB	0.2%	24.0%	329
Aluminum Beverage Cans EBB	0.1%	8.9%	123
Aluminum Beverage Cans None	0.0%	0.8%	11
Aluminum Foil, Pans & Food Cans	0.5%	66.2%	907

Institutional/Commercial/Industrial (ICI) MSW

Table 9 presents the results of the hand sort data for ICI MSW. As illustrated by Table 9, the overall composition of the ICI MSW is quite similar to that of Residential MSW, especially with respect to Organics and Paper. For example, Food Waste represents an estimated 40,852 tons of ICI MSW compared to 40,766 tons of Residential MSW.

Table 9. Composition of ICI MSW, Vermont, 2018[10]

Material	Estimated Percent	+ / -	Estimated Tons	Material	Estimated Percent	+ / -	Estimated Tons
Paper	**22.0%**	**2.6%**	**40,773**	**Organics**	**24.7%**	**3.3%**	**45,779**
Newsprint	0.4%	0.2%	822	Food Waste - Contained in Packaging	7.4%	1.9%	13,790
High Grade Office Paper	0.6%	0.5%	1,030	Food Waste - Loose	14.6%	2.7%	27,062
OCC (Old Corrugated Cardboard)	6.2%	1.3%	11,433	Leaves/Grass/Brush >1"	0.1%	1.1%	190
Magazines/Catalogs	0.4%	0.1%	654	Leaves/Grass/Brush <1"	0.2%	0.4%	341
Mixed Recyclable Paper	1.8%	1.0%	3,322	Pet Waste	1.4%	1.1%	2,574
Boxboard (chipboard)	0.9%	0.3%	1,738	Other Organics	1.0%	1.0%	1,821
Books	0.1%	0.1%	144				
Polycoated / Aseptic Containers	0.3%	0.1%	531	**Metal**	**2.9%**	**0.7%**	**5,405**
Compostable Paper	7.8%	1.2%	14,515	Aluminum Beverage Cans	0.4%	0.3%	737
Non-Recyclable Paper	3.6%	1.8%	6,583	Aluminum Foil, Pans & Food Cans	0.2%	0.1%	425
				Ferrous Containers	0.7%	0.4%	1,296
Plastic	**15.8%**	**3.0%**	**29,325**	Other Ferrous	1.1%	0.6%	2,064
#1 PET Bottles	0.6%	0.1%	1,148	Other Non-Ferrous	0.5%	0.4%	883
#1 PET Food and Dairy Bottles and Jars	0.1%	0.1%	232				
#2 HDPE Bottles	0.1%	0.0%	237	**Electronics**	**0.4%**	**0.6%**	**724**
#2 HDPE Food and Dairy	0.2%	0.1%	395	CED CRT's	0.0%	0.0%	3
#3 - #7 Bottles	0.1%	0.1%	193	CED Televisions & Monitors, non-CRT	0.2%	2.0%	345
Plastic Cups, Tubs and Lids	1.0%	0.2%	1,838	CED Desktop & Laptop Computers	0.0%	0.0%	0
Bulky Rigid Plastics > 1 Gallon	2.5%	2.5%	4,545	CED Computer Peripherals/Printers	0.0%	0.0%	0
Plastic Thermoforms	0.2%	0.0%	371	Banned, Non-CED electronics	0.1%	0.2%	177
Plastic Film Pouches	0.0%	0.1%	77	Small Appliances	0.1%	0.2%	199
Film - Retail Bags	0.3%	0.1%	546				
Film - ICI Wrap	3.0%	2.8%	5,497	**C&D**	**14.7%**	**3.3%**	**27,315**
Film - Garbage Bags	1.9%	0.4%	3,568	Drywall/Gypsum Board	0.5%	1.2%	910
Film - Other	2.1%	0.3%	3,899	C & D Metal	0.4%	1.2%	813
Other Plastic	3.7%	2.0%	6,779	Asphalt Shingles	0.2%	1.5%	328
				Plywood	0.7%	0.8%	1,296
Glass	**1.9%**	**0.8%**	**3,554**	Oriented Strand Board	0.0%	0.1%	45
Glass Beverage Bottles	1.2%	0.6%	2,293	Asphalt, Brick and Concrete	0.0%	0.0%	14
Food and Dairy Glass	0.2%	0.2%	417	Wood - Painted and Treated	4.4%	1.4%	8,099
Plate Glass	0.2%	1.7%	303	Wood - Clean	5.5%	2.5%	10,254
Other Glass	0.3%	0.4%	541	Other C & D	3.0%	1.8%	5,556
Special/Other	**17.1%**	**3.6%**	**31,743**	**Hazardous Waste**	**0.3%**	**0.3%**	**634**
Textiles and Leather	3.2%	1.8%	5,963	Paint	0.0%	0.1%	32
Rubber	0.6%	0.3%	1,019	Batteries (Primary)	0.0%	0.0%	49
Carpet and Carpet Padding	5.2%	4.0%	9,637	Batteries (Rechargeable)	0.0%	0.0%	2
Diapers/Sanitary Products	2.8%	1.5%	5,191	Mercury Thermostats/Thermometers	0.0%	0.0%	0
Furniture/Bulky Items	2.8%	2.5%	5,168	Mercury Lamps	0.0%	0.0%	7
Tires	0.1%	0.1%	195	Mercury - Other	0.1%	0.0%	223
Fines/Dirt/Mixed Residue	1.3%	0.4%	2,487	Other HHW	0.2%	0.1%	322
All Other Wastes Not Elsewhere Categorized	1.1%	0.7%	2,083				
				Grand Total	**100%**		**185,251**
				Sample Count	**86**		

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

[10] Note that while primary batteries were included under Hazardous Waste, they are in fact not classified as hazardous waste.

It is also interesting to note that C&D materials make up a significant percent of both Residential and ICI MSW at 9.9 and 14.7 percent of the total MSW respectively. And that Special Wastes represent 19.7 and 17.1 percent, respectively of Residential and ICI MSW even though bulky wastes are not included in these totals.[11] While carpet and padding is the largest category of Special Waste for ICI MSW, diapers and textiles are the two largest categories for Residential MSW. Diapers, especially, are a growing and significant component of Residential MSW, especially with the aging population.

Finally, electronics and HHW are a relatively small component of both the Residential and ICI MSW stream, indicating the success of EPR legislation for electronics and paint, and of HHW drop-off programs[12].

ICI Sub-Sort

Table 10 presents the results of the sub-sort of bottle bill and potential bottle bill materials from the ICI MSW. Interestingly, the results are very similar to those for the Residential MSW. However, bottles that would be part of the EBB are found to have a slightly higher incidence in the ICI stream, mainly glass.

Table 10. ICI Sub-Sort of Potential Bottle Bill Containers

Material Subsorts	Absolute Pct	Relative Pct	Tons
#1 PET Bottles	**0.7%**	**100.0%**	**1,380**
#1 PET Bottles BB	0.1%	15.1%	209
#1 PET Bottles EBB	0.5%	63.0%	870
#1 PET Bottles None	0.0%	5.1%	70
#1 PET Food and Dairy Bottles and Jars	0.1%	16.8%	232
#2 HDPE Bottles	**0.3%**	**100.0%**	**632**
#2 HDPE Bottles BB	0.0%	1.7%	11
#2 HDPE Bottles EBB	0.0%	9.6%	60
#2 HDPE Bottles None	0.1%	26.3%	166
#2 HDPE Food and Dairy	0.2%	62.5%	395
#3-#7 Bottles	**0.1%**	**100.0%**	**193**
#3 - #7 Bottles BB	0.0%	12.0%	23
#3 - #7 Bottles EBB	0.1%	52.0%	101
#3 - #7 Bottles None	0.0%	36.0%	70
Glass Beverage Bottles	**1.5%**	**100.0%**	**2,710**
Glass Beverage Bottles BB	0.4%	30.4%	824
Glass Beverage Bottles EBB	0.8%	51.4%	1,392
Glass Beverage Bottles None	0.0%	2.8%	77
Food and Dairy Glass	0.2%	15.4%	417
Aluminum Beverage Cans	**0.6%**	**100.0%**	**1,162**
Aluminum Beverage Cans BB	0.2%	33.3%	387
Aluminum Beverage Cans EBB	0.2%	29.2%	339
Aluminum Beverage Cans None	0.0%	0.9%	11
Aluminum Foil, Pans & Food Cans	0.2%	36.6%	425

[11] While bulky items and furniture picked up **with** residential waste and ICI waste are included, separate roll-offs of bulky wastes were not hand sorted and not included in this composition breakdown.

[12] As stated in Footnote 8, above, primary batteries were included in the Hazardous Waste category even though they are not hazardous waste, slightly inflating the total Hazardous Waste category.

Aggregate MSW Composition

The hand sort data were also aggregated to provide an overall picture of the composition of MSW disposed in Vermont. Table 11 presents the data.

In this case (Table 11) the Bulky Waste excluded from the Residential and ICI MSW tables (Tables 7 and 9, above) has been added back into the total (roughly 6% of MSW or 29,924 tons) to best illustrate the actual composition of all non-C&D wastes disposed in Vermont. The bulky waste tonnage was added into the category "Furniture/Bulky Items" even though some of this material might fall into other categories.

In addition, All Other Wastes from Table 3 that could not be classified as residential or ICI, mainly MRF residue and some MSW that made its' way into the BATS or Myers' C&D facilities but was transferred to a MSW transfer station, was also added back into the totals. This is estimated at 10,973 tons.

It should be noted that a significant amount of C&D waste is included in Tables 7, 9 and 11. This is C&D waste mixed in with residential and ICI loads, exclusive of loads categorized as C&D from the Gate Surveys (Table 3). The gate surveys classified C&D loads that were primarily C&D and allowed more accurate classification of C&D waste. The results of the visual surveys on C&D waste are presented in the next section and can be used to better estimate the composition of this portion of the waste stream.

Table 11. Aggregate Composition of MSW Disposed[13][14]

Material	Estimated Percent	+ / -	Estimated Tons	Material	Estimated Percent	+ / -	Estimated Tons
Paper	**19.9%**	**1.6%**	**83,880**	**Organics**	**24.4%**	**1.9%**	**103,127**
Newsprint	0.9%	0.3%	3,759	Food Waste - Contained in Packaging	7.3%	1.0%	30,653
High Grade Office Paper	0.4%	0.2%	1,579	Food Waste - Loose	12.1%	1.5%	50,974
OCC (Old Corrugated Cardboard)	3.9%	0.8%	16,319	Leaves/Grass/Brush >1"	0.1%	0.4%	300
Magazines/Catalogs	0.8%	0.3%	3,201	Leaves/Grass/Brush <1"	0.7%	0.8%	3,082
Mixed Recyclable Paper	1.5%	0.6%	6,528	Pet Waste	2.9%	0.7%	12,089
Boxboard (chipboard)	1.1%	0.2%	4,537	Other Organics	1.4%	0.6%	6,028
Books	0.3%	0.2%	1,272				
Polycoated / Aseptic Containers	0.3%	0.1%	1,162	**Metal**	**2.5%**	**0.4%**	**10,692**
Compostable Paper	8.4%	0.7%	35,403	Aluminum Beverage Cans	0.3%	0.1%	1,200
Non-Recyclable Paper	2.4%	0.9%	10,121	Aluminum Foil, Pans & Food Cans	0.3%	0.1%	1,332
				Ferrous Containers	0.6%	0.2%	2,582
Plastic	**12.7%**	**1.5%**	**53,712**	Other Ferrous	0.9%	0.3%	3,790
#1 PET Bottles	0.6%	0.1%	2,424	Other Non-Ferrous	0.4%	0.2%	1,788
#1 PET Food and Dairy Bottles and Jars	0.2%	0.0%	788				
#2 HDPE Bottles	0.1%	0.1%	618	**Electronics**	**0.7%**	**0.6%**	**2,965**
#2 HDPE Food and Dairy	0.3%	0.1%	1,182	CED CRT's	0.1%	1.0%	579
#3 - #7 Bottles	0.1%	0.1%	431	CED Televisions & Monitors, non-CRT	0.2%	1.9%	972
Plastic Cups, Tubs and Lids	0.9%	0.1%	3,840	CED Desktop & Laptop Computers	0.0%	0.1%	57
Bulky Rigid Plastics > 1 Gallon	1.5%	1.2%	6,487	CED Computer Peripherals/Printers	0.0%	0.0%	23
Plastic Thermoforms	0.3%	0.0%	1,308	Banned, Non-CED electronics	0.1%	0.1%	438
Plastic Film Pouches	0.0%	0.0%	178	Small Appliances	0.2%	0.3%	896
Film - Retail Bags	0.5%	0.1%	2,168				
Film - ICI Wrap	1.5%	1.4%	6,270	**C&D**	**11.1%**	**2.0%**	**46,823**
Film - Garbage Bags	1.7%	0.2%	7,270	Drywall/Gypsum Board	0.4%	0.7%	1,674
Film - Other	2.2%	0.2%	9,375	C & D Metal	0.2%	0.8%	895
Other Plastic	2.7%	1.0%	11,374	Asphalt Shingles	0.5%	1.2%	1,985
				Plywood	0.5%	0.7%	2,079
Glass	**1.9%**	**0.4%**	**8,102**	Oriented Strand Board	0.0%	0.1%	46
Glass Beverage Bottles	1.0%	0.3%	4,197	Asphalt, Brick and Concrete	0.0%	0.0%	140
Food and Dairy Glass	0.4%	0.1%	1,545	Wood - Painted and Treated	3.4%	0.8%	14,393
Plate Glass	0.1%	0.6%	545	Wood - Clean	3.1%	1.4%	13,255
Other Glass	0.4%	0.2%	1,815	Other C & D	2.9%	1.1%	12,357
Special/Other	**26.3%**	**2.0%**	**111,214**	**Hazardous Waste**	**0.4%**	**0.2%**	**1,742**
Textiles and Leather	4.2%	1.0%	17,830	Paint	0.1%	0.5%	389
Rubber	0.6%	0.2%	2,594	Batteries (Primary)	0.1%	0.0%	246
Carpet and Carpet Padding	3.1%	2.1%	12,918	Batteries (Rechargeable)	0.0%	0.0%	6
Diapers/Sanitary Products	3.6%	0.9%	15,403	Mercury Thermostats/Thermometers	0.0%	0.0%	0
Furniture/Bulky Items	9.1%	2.2%	38,298	Mercury Lamps	0.0%	0.0%	21
Tires	0.2%	2.4%	986	Mercury - Other	0.1%	0.9%	225
Fines/Dirt/Mixed Residue	1.5%	0.4%	6,494	Other HHW	0.2%	0.1%	855
All Other Wastes Not Elsewhere Categorized	4.0%	0.5%	16,691				
				Grand Total	**100%**		**422,258**
				Sample Count	**181**		

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

[13] Bulky wastes (29,924 tons) were added to the Furniture/Bulky Items subcategory and Other Wastes (10,973 tons) were added to Special/Other subcategory to better characterize waste disposal in Vermont. However not all bulky waste is furniture, but in the absence of characterization waste, this was a logical category to use as a placeholder.

[14] Note that while primary batteries were included under Hazardous Waste, they are in fact not classified as hazardous waste.

Table 12. Aggregated Sub-Sort of Bottle Bill Containers

Material Subsorts	Absolute Pct	Relative Pct	Tons
#1 PET Bottles	**0.8%**	**100.0%**	**3,565**
#1 PET Bottles BB	0.1%	17.1%	610
#1 PET Bottles EBB	0.4%	51.0%	1,819
#1 PET Bottles None	0.1%	7.2%	256
#1 PET Food and Dairy Bottles and Jars	0.2%	24.7%	880
#2 HDPE Bottles	**0.5%**	**100.0%**	**2,004**
#2 HDPE Bottles BB	0.0%	0.6%	12
#2 HDPE Bottles EBB	0.0%	10.5%	209
#2 HDPE Bottles None	0.1%	23.2%	466
#2 HDPE Food and Dairy	0.3%	65.7%	1,317
#3-#7 Bottles	**0.1%**	**100.0%**	**478**
#3 - #7 Bottles BB	0.0%	7.3%	35
#3 - #7 Bottles EBB	0.0%	25.7%	123
#3 - #7 Bottles None	0.1%	67.1%	321
Glass Beverage Bottles	**1.5%**	**100.0%**	**6,361**
Glass Beverage Bottles BB	0.4%	25.5%	1,621
Glass Beverage Bottles EBB	0.6%	42.9%	2,729
Glass Beverage Bottles None	0.1%	4.5%	286
Food and Dairy Glass	0.4%	27.1%	1,726
Aluminum Beverage Cans	**0.7%**	**100.0%**	**2,807**
Aluminum Beverage Cans BB	0.2%	28.2%	791
Aluminum Beverage Cans EBB	0.1%	18.0%	506
Aluminum Beverage Cans None	0.0%	0.9%	24
Aluminum Foil, Pans & Food Cans	0.4%	52.9%	1,486

IV. C&D Visuals

DSM was required to complete 40 hours of C&D visuals as part of the project. To address this, DSM allocated two days to the Burlington Area Transfer Station (BATS) and one day to the Meyers C&D recycling facility as well as performed additional surveys during the 20 days of Gate Surveys whenever C&D loads came into the facility.

In total, DSM conducted visual surveys of 59 C&D loads, of which three were primarily bulky wastes coming into the C&D processing facilities. Table 21 presents the number of surveys completed at each facility. Table 22 then presents the results of the visual surveys.

Estimated composition percentages have been applied to the adjusted C&D tonnage estimates calculated in Table 3 and made for FY 2018.

Table 13. C&D Visual Surveys by Location

Facility	# of Visual Surveys Completed
TAM	2
Addison	4
NEWS Direct	8
Hyde Park	3
Highgate	1
Meyers C&D	15
BATS	26
Total:	59

Clearly, as illustrated by Table 13, the surveys are weighted heavily toward deliveries in Chittenden County and to the two facilities that are either processing C&D or transferring for processing. This is because these facilities were most likely to receive a steady stream of C&D loads making it worthwhile for a trained enumerator to conduct visual surveys over the course of a day.[15]

Typically, based on DSM's experience in other states, this means that loads delivered to these facilities will be higher in metal, wood waste, and asphalt shingles, which are recoverable materials, as opposed to non-recoverable materials. In addition, heavy materials such as asphalt, brick and concrete tend to be delivered separately to recycling facilities specializing in these materials, or in the case of concrete, used in fill or construction projects directly, bypassing transfer stations and processing facilities where high load weights result in high tip fees per load.

For these reasons, it should not be assumed that the overall generation of C&D in Vermont is necessarily equivalent to the composition presented in Table 14.

[15] It was not feasible for the Project to assign trained C&D waste professionals to facilities where little C&D was received.

It is also important to caution that the confidence intervals shown in Table 14 are quite high meaning that the population mean may vary significantly from the sample mean used in Table 14. This is because of the relatively small sample size for C&D wastes which are both relatively heterogeneous, and because DSM conducted visual estimates as opposed to actually weighing all materials. For this reason, the report does not include extensive analysis of the C&D composition results.

Table 14. Estimated Composition of C&D Waste

Material	Estimated Percent	+ / -	Estimated Tons	Material	Estimated Percent	+ / -	Estimated Tons
Paper	**2.5%**	**1.8%**	**2,533**	**Metal**	**3.3%**	**2.1%**	**3,372**
Flattened OCC	1.4%	1.1%	1,424	Appliances	0.0%	0.0%	0
Unflattened OCC	0.3%	0.3%	308	Other Ferrous Metals	2.8%	2.1%	2,882
R/C and Other Paper	0.8%	1.0%	802	Other Non-ferrous Metal	0.5%	0.4%	461
				HVAC Ducting	0.0%	0.0%	29
Plastic	**2.0%**	**1.1%**	**2,032**				
Plastic Bottles (Recyclable)	0.0%	0.0%	0	**C&D**	**41.4%**	**13.6%**	**42,135**
HDPE Buckets (Stacked)	0.2%	0.2%	166	Carpet	0.6%	0.6%	642
HDPE Buckets (Unstacked)	0.1%	0.1%	91	Carpet Padding	0.3%	0.3%	331
Clean Recoverable Film	0.2%	0.1%	214	Concrete/Block/Brick/Stone/Tile	1.9%	3.2%	1,951
Vinyl Siding	0.1%	0.1%	56	Asphalt Paving	0.0%	0.0%	0
Vinyl Flooring	0.3%	0.6%	340	Roofing Materials	17.8%	10.4%	18,091
R/C and Other Plastic	1.1%	0.7%	1,165	Ceiling Tiles	0.2%	0.2%	197
				Clean Gypsum Board	6.3%	6.4%	6,425
Glass	**0.0%**	**0.0%**	**0**	Painted Gypsum Board	3.8%	2.6%	3,895
All Glass	0.0%	0.0%	0	Dirt/Sand/Gravel	2.1%	2.2%	2,178
				Foam Insulation	0.3%	0.2%	272
Wood	**34.6%**	**7.5%**	**35,174**	Fiberglass Insulation	2.0%	1.2%	2,012
Pallets - Standard	1.0%	0.7%	993	R/C and Other C&D	6.0%	2.9%	6,142
Pallets/Crates/Heavy	0.7%	0.9%	726				
Untreated/Unpainted Lumber	7.6%	2.3%	7,717	**Special Waste**	**15.8%**	**7.7%**	**16,050**
Treated/Painted/Processed Wood	10.8%	5.0%	10,968	Bulky Wastes/Furniture	6.6%	4.7%	6,679
Engineered Wood	13.5%	4.9%	13,733	Tree Trunks	0.0%	0.0%	0
Wood Furniture	0.5%	0.6%	547	Tires - Cut	0.0%	0.0%	0
Other Wood	0.5%	0.4%	490	Tires - Whole	0.0%	0.0%	0
				All HHW	0.0%	0.0%	0
Organics	**0.5%**	**0.4%**	**463**	Fines/Mixed Residue	8.3%	6.5%	8,408
Leaves/Grass/Mixed Yard Waste	0.4%	0.4%	435	Mixed MSW	0.9%	0.5%	963
Branches/Limbs	0.0%	0.0%	29				
R/C and Other Organics	0.0%	0.0%	0	**Other Waste**	**0.0%**	**0.0%**	**0**
				Agricultural Waste	0.0%	0.0%	0
Electronics	**0.0%**	**0.0%**	**0**	Contaminated Soil	0.0%	0.0%	0
Electronics	0.0%	0.0%	0				
Items with CRTs	0.0%	0.0%	0	**Grand Total**	**100%**		**101,760**
				Sample Count	**59**		

Confidence intervals calculated at the 90% confidence level. Percentages for material types may not total 100% due to rounding.

V. Survey of Home Composting

DSM sub-contracted with the Castleton Polling Institute (CPI) to develop and carry out a survey of Vermont households to estimate participation in backyard composting of food waste. DSM worked with CPI to design survey questions to not only capture their participation in backyard composting, or in separating food waste from trash, but to report on their behavior in the past week in order to collect estimates of the amount of food waste managed through composting.

Appendix B contains CPI's methodology in a report to DSM detailing their findings associated with the survey. DSM has modified the results in an attempt to account for the following issues inherent in a survey of this type:

- The impact of self-selection bias on survey participation;
- The impact of socially desirable behavior on participant's responses; and,
- The impact of seasonal behavior on annual volume estimates.

The modified results were used to estimate annual, statewide diversion of food waste through backyard composting.

Self-Selection Bias

It stands to reason that households who participate in backyard composting of food waste would be more willing to take the time to read and complete the four-page mail-in survey than those who were not. Based on discussions with CPI, the fact that survey participants fit the demographic profile of Vermont households and that a significant number of responses report no backyard composting, it is CPI and DSM's opinion that while some self-selection bias does exist in this survey, it probably has a relatively minor impact on the results.

Distortion Due to Perceived Socially Desirable Behavior

"*Social desirability is a term used to explain the tendency of people to answer questions in a socially acceptable manner during surveys…The behavior stems from the basic need and tendency of people to be in sync with the popular opinion, politically correct response, or the desirable response regarding a subject so that they are viewed in a more positive light….the social desirability bias is also observed in matters of littering and recycling.*"[16]

DSM's work has focused on conducting studies and drawing any conclusions about recycling activity by collecting data on actual/observed (recycling) behavior rather than reported behavior because DSM has learned over time that people over-report their behavior with respect to recycling (both participation in and the amount they recycle) when compared to how they actually performed recycling. For example, it was not uncommon for people who received curbside collection of refuse but had to drive to a drop-off to recycle to significantly over-report their use of the drop-off, and under-report how far they drove to use the drop-off. Households self-reporting behavior were as high as 30 percent of households reporting regular recycling

[16] https://psychologenie.com/ways-to-reduce-social-desirability-bias

compared to actual surveys conducted at the drop-offs in the same region measuring use below 10 percent, and the amount of actual driving (to use the drop-offs) measuring significantly higher than that which was self-reported.

Unfortunately, there was no way to efficiently obtain actual behavior data for backyard composting for comparison because the practice occurs at home as opposed to a public location. The other options of in-person interviews, or recruitment of households to fill out a diary of their behavior, do not control for answers based on socially desirable behavior and exacerbate the propensity for those in favor of backyard composting to self-select to participate in the survey. As such, DSM agreed with the CPI that a mail-in survey was the best possible method to derive estimates of the percent of Vermont households practicing some amount of backyard composting.

However, DSM continues to believe that the socially desirable nature of backyard composting, coupled with some degree of self-selection bias, probably over-estimates the number of households who actually perform backyard composting on a regular basis, and the amount of food waste that they reportedly divert through backyard composting.

DSM is not aware of any other state-wide surveys of backyard composting that use techniques other than self-reported behavior, so it is difficult to know what impact self-selection and social desirability might have had on the CPI survey results. Further a review of the literature doesn't provide any methodologies for correcting for these biases after the survey is complete.[17]

However, it is possible to compare the survey results against recent measured participation rates for weekly curbside collection of source-separated food waste in South Portland and Scarborough, Maine conducted by ecomaine. Actual participation rates for the free, weekly food waste curbside collection programs in South Portland and Scarborough were measured at 37 and 44 percent, respectively.

It is DSM's professional opinion that the real rate of household participation in backyard composting in Vermont is probably closer to this range than to the 58 percent reported by survey participants (See Table 15 and the following discussion of results).

Impact of Seasonal Behavior

As shown in Table 15, a total of 58% of surveyed Vermont households reported some separation of food waste from their trash. However, the majority of households reported more than one behavior with respect to how they managed their food waste.

Backyard composting in cold climates inevitably has some impact on household participation. Table 15 below attempts to further quantify the answers provided by the survey respondents to develop an estimate of how much food waste is actually diverted for composting/animal feeding on an annual basis in Vermont – which is the ultimate goal of the survey. As illustrated by the calculations in Table 15, DSM has adjusted the survey results two ways.

First, CPI asked about the quantity reported composted "last week" which DSM adjusted down based on those that reported participating in separating food waste but that also reported on what percent of food

[17] Correcting for these biases as part of the survey methodology is also difficult, would have been outside of the budget for this project, and may not have been successful in any case.

waste they disposed in the trash last week, as opposed to set aside for composting. This results in an estimated average of 8.3 pounds of food waste diverted on a weekly basis from the average participating household based on self-reported behavior of last week.

Second, DSM has attempted to adjust the results to reflect the fact that the survey was taken during late spring/early summer when inclement weather is less likely to serve as a disincentive to walk out to the compost pile, and the amount of fresh garden vegetables is increasing. While it is not possible to know from the survey how that behavior changes in the winter, survey participants did report on whether their behavior differs over the course of the year, and in the winter. Based on these data, DSM estimated that quantities and participation are lower in the winter. For lack of a better estimate, DSM assumed that quantities are cut by 50% for those who report they change their behavior over the course of the year.

Based on these two adjustments, this results in an estimate of roughly 27,600 tons (rounded) of food waste diverted from Vermont households to composting and animal feeding the past year, as shown in Table 15.

Table 15. Adjustments to CPI Survey Results to Derive Estimate of Total Food Waste Diversion Through Backyard Composting and Animal Feeding

Description	Percent	Households	Lbs./Week
Households that set aside any amount of food waste for anything other than disposal	58%	150,351	
Average amount set aside by these households (Gallons)	2.15		
Average weight per gallon in kitchen bin (Pounds)	5		
Total weight set aside last week	10.75		1,616,273
Last week behavior, percent of food waste reported placed in trash:		150,351	
100%	10.1%	15,185	0
75%	3.8%	5,713	15,355
50%	5.4%	8,119	43,639
25%	28.2%	42,399	341,842
0%	52.5%	78,934	848,543
	100.0%		1,249,379
Quantity Diverted From Trash Last Week *(Average Household Lbs/Week):*			**8.3**
Annualized behavior			**Lbs./Year**
Set aside all year	69.8%	104,945	45,347,468
Less in winter	23.0%	34,581	7,471,288
Varies, just not in winter	4.6%	6,916	1,494,258
Don't know	2.6%	3,909	844,580
			55,157,594
Total Tons			**27,579**
Lbs/Participating Household			**367**

It is important to note here that not all of the 27,579 tons is diverted through backyard composting or animal feed since a smaller percentage of households answered that they bring their food waste to a drop-off location or set it out for curbside collection. While it is difficult given the ability for the respondent to answer with more than one option, it is DSM's best estimate when looking at the raw data that roughly 10 percent of the material is not diverted to backyard composting. That would mean that backyard composting and animal feeding represents roughly 24,800 tons.

Pounds Per Household Comparison with Ecomaine Pilots

As illustrated by Table 15, it is estimated that the average composting household diverts 367 pounds of food waste from disposal per year. Adding in the percent that the surveyed composting households stated they disposed in the trash yields a total estimated generation rate of 559 pounds per household per year. This can be compared against the actual weigh data from the South Portland pilot collection[18] of 525 pounds set out per participating household per year which is within six percent of the estimate for Vermont households, suggesting that the estimated per household quantity from the survey is realistic.

Comparison with Hand Sort Results

Based on the results of the hand sort data applied to an estimated residential MSW disposal of 196,110 tons of MSW, 40,776 tons of food waste were disposed by Vermont households. Dividing by 257,107 households (US Census, 2016 estimate) yields a per household annual disposal rate of 317 pounds per household per year. One can then add the 27,579 tons estimated to be diverted for composting – primarily through backyard composting (see above) to arrive at a total per household generation rate of 532 pounds per household per year, or a current food waste diversion rate for residential food waste of 40 percent.[19]

Yard Waste

In addition to food waste, many households divert yard waste. Some include some or all of their yard waste in their compost pile, but many simply place yard waste in the woods or area of the yard that is not maintained. Yard waste diversion is over and above food waste diversion and is not estimated by this survey. However, as indicated by the hand sort data, only 2,800 tons (rounded) of yard waste including brush was found in residential waste.

It should also be noted that the US EPA does not include backyard composting in their measurement of MSW recycling even though clearly it contributes to food waste diversion in Vermont.

[18] There were only five months of data for Scarborough, while there were 12 months of data for South Portland. Note that we do not know how much South Portland HH's may have disposed in refuse of put down garbage grinder.

[19] Note that this is not the same as a recycling rate but is closer to a recycling material capture/recovery rate. DSM typically sees recyclable material diversion (capture/recovery) rates ranging from 50 to 80 percent by comparison.

VI. Economic Recycling Survey

"Economic recycling" takes place when a business or institution contracts with an end-user directly or through a broker to deliver recyclables generated by the business or institution, bypassing a Vermont materials processing facility. The materials sent directly to market (or to an out-of-state broker or facility) by the generator are not captured by the quarterly reports submitted to the DEC by recycling facilities located in Vermont but can be a significant part of a State's recycling activity. For this reason, many states want to include this activity when measuring their diversion rate.

Methodology

DSM designed a survey approach to identify and quantify economic recycling activity. The survey began in late April 2018 and undertook the following methodology.

First, DSM developed a survey form and introductory letter explaining the data request to introduce the project to potential economic recyclers and collect data by email or facsimile. This included a letter signed by the DEC authorizing the project and asking for cooperation.

Second, DSM developed a list of Vermont companies that might be engaging in economic recycling by reviewing data from the Vermont Department of Labor on the largest employers located in the state. This list was supplemented by other business lists and then reviewed to identify and remove any companies that were unlikely to generate large volumes of recyclables or engage in direct-to-market recycling. DSM then added to the list any missing large retailers and grocers that were likely to be backhauling packaging materials such as cardboard and shrink wrap to a central distribution center.

Finally, DSM performed online research to identify recycling companies and brokers that were believed to be doing business in Vermont but that may not operate a Vermont certified recycling facility.

From this research, a final database was developed of 180 locations of potential generators (business and institutions) and another 18 businesses that were believed to be handling or brokering recyclables but that were unlikely to report to the VT DEC. This excluded scrap metal yards located in Vermont which were not part of the survey.

The final survey list of 180 locations included businesses operating in the retail, grocery, health care, banking/insurance, institutional, manufacturing and wholesale industries. From this contact list, DSM was able to reach someone at 140 locations of which information or completed reports were provided by 110. The balance, representing 30 locations, notified DSM that they would not participate.

The survey list of the 18 recycling processors, end-users and/or brokers was based on online research, DSM's knowledge of the marketplace, and DSM industry contacts. DSM contacted these recyclers in the same manner Vermont generators were contacted but attempted to gain additional information including a list of clients that they had in Vermont (to avoid double counting of materials) and any potential competitors that may not have been previously identified (to help ensure all recyclers serving Vermont were surveyed). In the end, 12 of the 18 recycling companies provided some data or completed survey forms. In all cases survey respondents were able to request that their data be kept confidential. Due to this, tonnage data reported for economic recycling is aggregated and does not represent any individual business.

Surveys were carried out using different contact methods. In most cases DSM first attempted to make contact by telephone in order to explain the project and data request and determine if the business was using a Vermont hauling company or recycling facility to handle their recyclables. In the case where the business verified use of a Vermont hauler or recycling facility, DSM entered this information in the database and the survey was deemed completed. However, if they did not use a Vermont hauler or facility, the DSM representative further explained the study and data request and asked for more specific contact information to send the survey form and the letter from VT DEC. DSM attempted to contact all of the identified businesses and recyclers at least three time by phone and twice by e-mail (when possible).[20]

Third, DSM created from the contact list a database to track material volumes and flow, and account for any potential double counting. In instances where a specific company did not participate in the survey, and DSM deemed their presence within the state significant, DSM used data previously reported by the company (in other states) or related industry reports to estimate their volumes managed in Vermont. In cases where a specific company reported for only one location, DSM used that location report to create estimates for the other locations in Vermont. These estimates were only used in about 10 cases.

Industry Categories

Industry categories were used to classify the business type to better understand economic recycling trends within each industry sector. Industry categories used were:

- *Retail – represented big-box stores, department stores, pharmacies and grocers. Retail stores generate significant packaging materials which include corrugated cardboard (OCC), film, plastic, pallets, etc. Additionally, many grocers have fat, oil, and grease (FOG) recycling programs as well as food rescue or food waste collection programs in place.*

- *Manufacturing and Wholesale – includes companies located in Vermont who manufacture or wholesale materials or goods and employ more than 100 people. Companies operating within these industries may generate OCC, paper, film and plastics, as well as metals and pallets used to transport their materials.*

- *Recyclers – companies in and surrounding Vermont that may be involved in brokering materials generated in Vermont and/or processing materials generated in Vermont. These materials would not be transferred through a Vermont transfer station and thus, would likely not be included in any recyclers report to the State. Recyclers primarily reported OCC, paper and metals.*

- *Institutions– represents universities, medical facilities or any other institutions located within Vermont and that employ more than 250. Institutions frequently use Vermont recycling facilities but may have unique materials that may need to be recycled outside of the traditional recycling stream.*

[20] In some cases, automated phone systems led DSM to leave messages on a general mailbox that was not returned, or found the mailbox was full and DSM could not leave messages. In other cases, a general mailbox had to be used to send emails.

Material Categories

The material categories were essentially similar to the material types processed at Vermont MRFs plus fats, oils and grease, and scrap metals. It is important to note that in the case where no tonnages were reported to DSM, the material group was not included in the results section. Additionally, when materials were reported as recycled that are not included in the material list, these materials were put into the 'Other' material category. Finally, metals typically found in construction waste or from automobiles, other vehicles or transportation related were not accounted for as they are not part of municipal solid waste.

Survey and Data Limitations

DSM's methodology for estimating economic recycling only counts material reported to be recycled and does not make per capita, per employee, or other estimates based on recycling coefficients except in the case where a specific large retailer, wholesaler or recycler did not report for a location and DSM was able to use estimates from other locations. This methodology is more likely to under-report than over-report economic recycling activity due to the fact that some generators and brokers have likely not been identified or have not participated in the survey.

As reporting is not mandatory, DSM relied on voluntary participation. Data from some companies that did not participate may impact actual economic recycling figures. Despite DSM's best efforts to gain participation, some companies reported that they have a policy to only participate in surveys when it is mandatory. And some companies that did participate do not track their recycling data (as they have no reason to do so) and relied heavily on their own estimates to provide tonnage data.

The final estimates made by DSM are only as good as the data provided. DSM focused heavily on information provided by large retailers as they generally have the highest economic recycling generation activity. DSM assumes that the submitted retailer recycling activity report forms are accurate for the State of Vermont. Additionally, DSM relied on all reporters to accurately identify the end-user or processor for their materials to avoid double counting of these materials.

For three material categories - shredded paper, electronics, and Fat, Oil and Grease (FOG) – the lack of participation resulted in low volumes reported. DSM attempted to make tonnage estimates for these sectors based on the data available, although these estimates may still under represent total volume.

Finally, scrap metals recyclers were not part of the survey nor was scrap metal found in construction debris even if it was recycled. And if the company used a Vermont based hauler to pick up non-construction related scrap metal to take it to a Vermont facility, they did not report these metals. Therefore, as is the case in all states, it is extremely difficult to accurately track scrap metal recycling and follow the definitions for municipal solid waste recycling which tracks only metal packaging and durables, including appliances. Without a complete survey of, and mandated participation by, the scrap metal recycling facilities in Vermont detailing the types of scrap metal they handle, scrap metal recycling from the institutional, commercial, and industrial sector is impossible to accurately track.

Results

A total of 28,700 tons (rounded) were estimated to be diverted through economic recycling. Figure 3 illustrates the major material categories, by weight, and Table 16 lists the estimated tons by material category, and by the sector reporting the materials.

Figure 3.
Vermont Economic Recycling by Material Category
(Percentage by Weight, FY 2018)

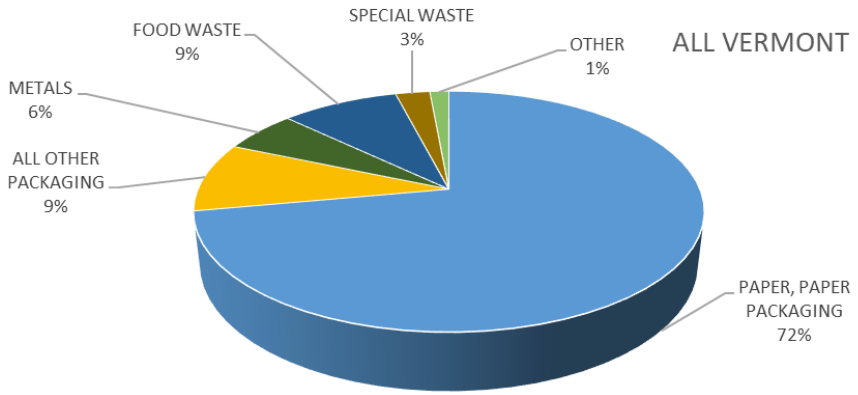


Table 16. Results by Material Category and Sector

Material Category	Retail		Manufacturing/Wholesale		Recyclers		Institutions		All Vermont	
	(Tons)	(%)	(Tons)	(%)	(Tons)	(%)	(Tons)	(%)	(Tons)	(%)
Paper, Paper Packaging (1)	11,185	54%	3,115	15%	6,407	31%	-	0%	20,707	72%
All Other Packaging (2)	2,396	89%	290	11%	-	0%	-	0%	2,686	9%
Net Packaging:	**13,581**	**58%**	**3,405**	**15%**	**6,407**	**27%**	**-**	**0%**	**23,393**	**81%**
Special Waste (3)	78	10%	95	13%	566	76%	7	1%	746	3%
Food Waste (4)	1,902	75%	-	0%	650	25%	-	0%	2,552	9%
Metals	299	19%	930	58%	234	14%	153	9%	1,616	6%
Other (5)	368	89%	23	6%	22	5%	-	0%	413	1%
Total	**16,229**	**57%**	**4,452**	**16%**	**7,879**	**27%**	**161**	**1%**	**28,721**	**100%**

1) *Paper, Paper Packaging includes old corrugated cardboard (OCC), mixed office paper, and sorted office paper. Paper, Paper Packaging also include roughly 750 Tons of OCC being sold for reuse.*
2) *All Other Packaging includes tonnages reported for the following materials: plastic film, retail bags, plastic bottles/containers, aluminum cans, polystyrene, mixed recycling (single stream or co-mingled), and pallets.*
3) *Special Waste includes tonnages reported for textiles and electronics/electronic goods.*
4) *Food Waste includes food being sent to farms outside of Vermont for compost as well as spent grain to farms and food donations.*
5) *Metals includes white goods/appliances and metal resulting as a byproduct of production.*
6) *Other Waste includes tonnages reported for tires, lead-acid batteries, used oil filters, fluorescent bulbs, used motor oil, mixed plastics/other plastics and food donations.*

As presented in Table 16, the retail sector reported the majority of the material counted as economic recycling, Tables 17 – 22 provide more detail on each material category.

Paper, Paper Packaging

Table 17. Paper and Paper Packaging

PAPER AND PAPER PACKAGING	
Material Type	**Tons**
OCC (old corrugated containers)	13,774
ONP (old newspapers)	0
Sorted Office Paper (1)	769
Mixed Paper	6,164
Total	20,707

Footnote:
1. Sorted Office Paper total includes 650 estimated tons.

Paper and paper packaging represent roughly 20,700 tons, or 72% of the total economic recycling activity estimated for Vermont last year. Paper and paper packaging generation are largely influenced by the retail industry which includes grocers, department stores and large big-box stores that frequently engage in backhauling of materials to a centralized distribution center, bypassing Vermont recycling facilities.

Recycling brokers managed roughly 30% of the paper and paper packaging. These recyclers primarily are picking up source separated cardboard and paper and are brokering them direct to mill.

In other case's the mills work directly with individual companies that generate large amounts of paper and paper packaging.

Manufacturers and Wholesalers represented 15% of total paper and paper packaging recycled. These materials are the byproduct of producing and/or packaging goods for sale and are primarily source separated.

As illustrated by Table 17, nearly 14,000 tons of cardboard were reported. Cardboard is primarily generated in the retail industry where it is kept separated and baled onsite and then backhauled to a centralized distribution center to be brokered.

In addition, roughly 6,200 tons of mixed paper were reported, along with an estimated 769 tons of sorted office paper. Mixed paper was reported both by paper mills and by companies operating within the printing industry. Sorted office paper was primarily reported by document destruction companies and is likely to be underestimated due to the lack of participation by these businesses. To counteract this, DSM used industry data to estimate generation of sorted office paper by document destruction companies operating within Vermont.

All Other Packaging:

The category, "all other packaging" represents 2,700 (rounded) tons, or 9% of the total economic recycling. As with paper and paper packaging, all other packaging tons are largely generated in the retail sector and include materials such as shrink wrap, retail bags and pallets that are used to transport goods in bulk for retail sale. The retail sector generally backhauls these materials to their central distribution location and brokers them from that location.

The manufacturing /wholesale sectors also generate some materials included in the all other packaging category. As with paper and paper packaging, these materials are generally the by-product of production and packaging.

Table 18. All Other Packaging
(At right)

ALL OTHER PACKAGING	
Material Type	**Tons**
Mixed Glass (bottles)	320
Plastic Film / Shrink Wrap	278
Plastic Retail Bags	129
Plastic Bottles and Containers (all Resins	194
Polystyrene Packaging	3
Aluminum Cans and Food Containers	0
Single Stream or Mixed Recyclables	2
Pallets, mulched and other	1,761
Total	2,686

Plastic Film/Shrink wrap was reported to be roughly 280 tons and plastic retail bags were reported at roughly 130 tons. Plastic Film/Shrink Wrap are used to package goods and are a result of the retail and industry/wholesale sectors. Plastic retail bags are reported by grocers and other retailers and estimated as a percentage of the plastic film generated per location.

Pallets represent 1,800 tons (rounded). As with plastic film/shrink wrap, pallets are used in the packaging process to ease transport and are primarily reported by retailers and the industry/wholesale sectors.

Mixed glass is reported to be 320 tons. Mixed glass reported is assumed to not include glass that would be collected under the bottle bill.

Special Waste

The special waste category includes textiles and electronic goods and represents 750 tons (rounded) or 3% of total economic recycling in Vermont. Special waste is a category where tonnages may fluctuate as industries update their electronics or generate an unusual waste stream that they be able to divert.

Table 19. Special Wastes

SPECIAL WASTES	
Material Type	**Tons**
Textiles	83
Electronics/Electronic Goods (1)	663
Total	746

Footnote:
1. Electronics/Electronic Goods total includes 280 estimated tons.

Electronics accounted for an estimated 660 tons whereas textiles accounted for roughly 80 tons. Electronics are frequently backhauled by retail companies or handled by large asset management companies responsible for data destruction. Due to Vermont's landfill disposal requirements, Vermonter's are required to recycle electronics and some businesses are likely bringing them to free drop off locations.

The lack of participation by document destruction companies (who also handle electronics as well as printed documents) required DSM to make some estimates for electronics using industry data, however DSM still believes electronics recycling activity has been underestimated.

Food Waste

Table 20. Food Waste

FOOD WASTE	
Material Type	**Tons**
Food Waste	1,856
Fats, Oils, Grease (FOG) (1)	696
Total	2,552

Foodnote:
1. FOG total includes 650 estimated tons.

Food waste recycling represents roughly 2,550 tons or 9% of the total economic recycling within Vermont. This recycling is reported to be happening solely in the retail industry and includes food waste as well as fat, oil, and grease (FOG) recycling.

Food rescue and food waste recycling is reported to be 1,900 tons which is going to out of state facilities. In contrast, FOG is estimated to be roughly 700 tons. DSM believes FOG is underestimated based on data reported in other states and the large number of restaurants and food service businesses in Vermont.

Metals

Table 21. Metals

METALS	
Material Type	**Tons**
Scrap Metals	1,544
White Goods / Appliances	72
Total	1,616

Metal recycling represents roughly 1,600 tons or 6% of the total economic recycling within Vermont. Metal recycling includes the reported recycling of while goods/appliances as well as the recycling of non-construction related scrap metals or durables. Roughly 1,500 tons of scrap metal were reported and 70 tons of white good/appliances. The majority of metal recycling was reported to be occurring by recycling companies themselves as well as by those companies operating in the manufacturing/wholesale sector. White good/appliance recycling was reported solely by the retail industry and these materials were either backhauled to a central distribution center or sent to a national appliance recycling business.

Other Waste

Table 22. Other Waste

OTHER WASTE	
Material Type	**Tons**
Mixed Plastics/Other Plastics	109
Other Recyclables	304
Total	413

Other waste represents about 1% of total economic recycling. Mixed Plastics/Other Plastics are reported to be 109 tons. Mixed Plastics/Other Plastics include materials such as plastic hangers, gift cards, and industrial barrels. Other recyclables are reported to be roughly 300 tons and include materials such as tires, oil filters, waste oil, and lead acid batteries that were sent for recycling.

Conclusions

Based on the survey of economic recycling activity in Vermont, and the few estimates made for missing data points, DSM estimates that roughly 29,000 tons of materials were diverted from disposal through economic recycling in Vermont last year. This recycling is occurring in addition to the tons reported as recycling to the Vermont DEC by certified Vermont recycling facilities. As illustrated in Tables 14 – 20 and covered in the discussion above, DSM has chosen to round our estimates to reflect the uncertainty associated with estimating economic recycling in Vermont.

While this estimate is a decrease from the tons reported in the *2001 Study of Economic Recycling in Vermont*, DSM believes that the difference is not reflective of less recycling performed by these larger Vermont businesses and institutions but instead that the recycling industry within Vermont is more mature, and therefore provides the necessary infrastructure to handle much of this material from large Vermont generators. In other words, material that may have gone out of state to be consolidated with other material before being sent to an end user is instead sent to a recycling facility permitted by the State of Vermont who therefore already reports on much of the material generated by the larger businesses and institutions.

A second factor contributing to less OCC and other packaging material being reported by the retail sector is the growing trend in online sales, which results in products being mailed directly to the consumer along with the packaging that now must be recycled from the home or small business instead of from the retailer.

A third but important factor is the decline in paper used in printing and in the workplace. Electronic media and documentation have decreased waste paper recycling and recovery since 2001.

VII. Comparison Among States

DSM and subcontractor MSW Consultants have recently conducted similar statewide waste composition studies in Connecticut (2015), Rhode Island (2015) and Delaware (2016). Because the Project Team is essentially the same for Vermont as for these other three states, the sampling and sorting protocol are also the same, making comparisons relatively easy.

The primary difference can be found in the material categories selected, which varied somewhat depending on the needs of the individual states. This requires combining of some categories to provide a fair comparison.

Table 23 presents the composition results for Residential and ICI MSW for each of the states based on the average percent by weight of each material type. For comparison purposes the 90 percent confidence interval for Vermont has been included so that one can see if the material averages for the other states fall within the range of likely values for Vermont.

Table 23. Comparison of Vermont MSW Composition to Delaware, Rhode Island and Connecticut

Material	**Vermont**		**Delaware**	**Rhode Island**	**Connecticut**
Year	*2017*		*2016*	*2015*	*2015*
	(%)	+/- (1)	(%)	(%)	(%)
Residential					
Paper	22.0	1.9	21.4	18.5	20.0
Recyclable (2)	*8.6*		*10.1*	*6.7*	*9.4*
Plastic	12.4	0.9	12.9	11.4	10.7
Recyclable Bottles (3)	*1.3*		*2.8*	*1.1*	*1.5*
Food Waste	20.8	1.3	20.2	20	20.0
Other Organic	8.5	2.1	8.4	9.3	10.2
Metal	2.7	0.4	3.3	3.1	2.8
Glass	2.3	0.4	3.6	1.6	2.8
C&D	9.9	2.2	9.3	9.6	10.1
Electronics	1.1	1	2.6	0.7	0.4
HHW	0.6	0.3	0.5	0.5	0.8
Other Wastes	19.7	2	17.7	24.2	22.1
ICI					
Paper	22	2.6	26	31.2	27.5
Recyclable (2)	*10.3*		*14*	*18.7*	*13.8*
Plastic	15.8	3	16.9	12.4	13.3
Recyclable Bottles (3)	*0.9*		*2.5*	*1.4*	*1.3*
Food Waste	22	2.3	21.9	17.5	25.5
Other Organic	2.7	3.3	6	4.4	4
Metal	2.9	0.7	2.9	2.8	3.8
Glass	1.9	0.8	1.7	2.6	2.1
C&D	14.7	3.3	11.9	12.9	10.6
Electronics	0.4	0.6	0.3	0.9	0.7
HHW	0.3	0.3	0.5	0.6	0.7
Other Wastes	17.1	3.6	11.9	13.9	11.9

Table 23 Notes

(1) Confidence interval for Food and Other Organics is an approximation based on combined intervals.
(2) Includes OCC, News, Paperboard, White Papers, Magazines and Catalogs, Phone Books.
(3) PET and HDPE Bottles only.

As illustrated by Table 23 Vermont falls squarely in the range of the other three states, with the exception of ICI Paper. Vermont is lower than the other states for the percentage of paper found in ICI waste falling slightly below the low end of the confidence interval range for Delaware and well below Rhode Island and Connecticut.

Food Waste

Because of Act 148 there is a lot of interest in Vermont in how much food waste is being disposed and how that compares to other states. Table 24 provides that comparison for the same three states based on the recent waste characterization studies and the estimated tons of MSW disposed in that state.

Table 24. Comparison of Per Capita Food Waste Disposal, Vermont, Delaware, Rhode Island and Connecticut

States	Tons	Population	Lbs./Cap	Year
Delaware (Total)	131,998	945,934	*279*	2016
Residential	64,912	945,934	*137*	2016
Connecticut (Total)	519,832	3,591,000	*290*	2015
Residential	272,655	3,591,000	*152*	2015
Vermont (Total)	81,628	627,103	*260*	2017
Residential	40,776	626,687	*130*	2017
Rhode Island				
Residential	60,577	1,056,423	*115*	2015

(1) Only the composition of residential waste is available for Rhode Island due to out of state disposal of ICI waste.

As shown in Table 24, Vermont falls below Connecticut and Delaware but above Rhode Island in terms of food waste disposal per capita both in the residential sector and overall. Rhode Island data are only available for the residential sector because a large portion of the ICI waste generated in Rhode Island is disposed out of state and was not include in the waste characterization study performed for Rhode Island.

Vermont Over Time

Finally, Table 25 below compares waste composition data from the past two statewide waste composition studies against this most recent study.

There are several important factors to consider when reviewing Table 25. First, the 2012 waste characterization allocated 60 percent of waste disposed to residential and 40 percent to ICI MSW. The use of gate surveys in 2018 significantly changed these percentages. As such comparison of tons by material type across the two studies is of limited value.

Second, the more important change is the proper allocation of C&D waste which has made the 2017/2018 data more accurate than the 2012 and the 2002 data. While C&D is often mixed in with MSW in small quantities, accounting for full C&D loads separate from MSW leads to a much more accurate representation of the tons by material type for both the residential and ICI MSW stream.

Therefore, to the extent it is important to compare the three studies, comparing the estimated composition percentages is more accurate than comparing the tonnages.

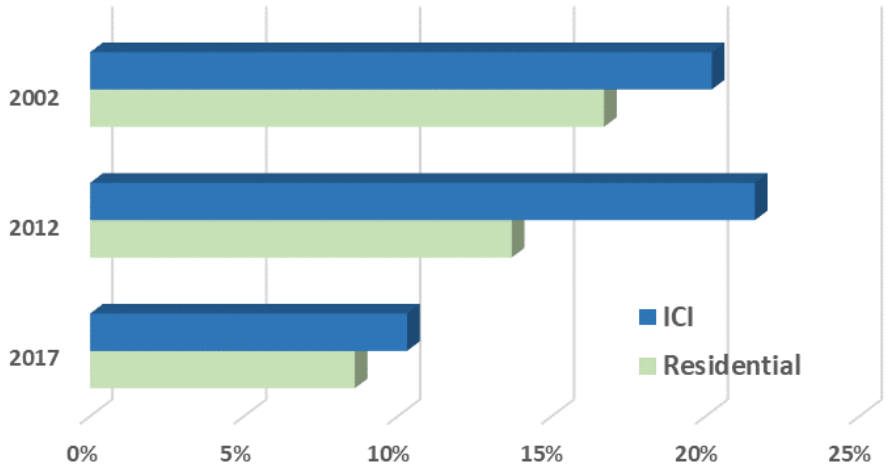
Table 25. Comparison of Vermont's Current Residential and ICI MSW Composition to Past Studies (2012 and 2002 Data)

Year	***2017***		***2012***		***2002***
MATERIAL	(%)	(tons)	(%)	(tons)	(%)
Residential					
Paper	22.0	43,107	22.2	54,978	28.1
Recyclable (1)	*8.6*	16,923	*13.7*	*34,032*	*16.7*
Plastic	12.4	24,387	10.8	26,899	9
Recyclable Bottles (2)	*1.5*	*2,999*	*1.39*	*3,411*	*1.8*
Food Waste	20.8	40,776	16.7	41,486	
Other Organic (3)	8.5	16,573	11.4	28,222	22
Metal	2.7	5,287	3.6	8,842	4.6
Glass	2.3	4,548	1.8	4,492	2.8
C&D	9.9	19,509	10.2	25,217	4.6
Electronics	1.1	2,240	2.2	5,544	1.8
HHW	0.6	1,108	0.2	423	0.6
Other Wastes	19.7	38,574	21	52,007	22.4
Total Residential		196,110		248,110	
ICI					
Paper	22	40,773	27.7	45,752	20.7
Recyclable (1)	*10.3*	*19,000*	*21.6*	*35712*	*20.2*
Plastic	15.8	29,325	12.2	20198	9.8
Recyclable Bottles (2)	*1.1*	*2,012*	*0.96*	*1559.7*	*2.2*
Food Waste	22	40,852	11.2	18,592	
Other Organic (3)	2.7	4,927	6.3	10,439	36.6
Metal	2.9	5,405	2.7	4,466	5.3
Glass	1.9	3,554	1.2	2,001	1.6
C&D	14.7	27,315	15.5	25,625	2.3
Electronics	0.4	724	1.5	2,466	4
HHW	0.3	634	0.1	217	0.3
Other Wastes	17.1	31,743	21.6	35,651	19.5
Total ICI		185,251		165,407	
Bulky Waste and Other Waste (4)		*40,897*			
Total MSW		422,258		413,517	

(1) ONP, OCC, Magazines, Boxboard and Mixed Paper.
(2) All Bottles except #3 - #7.
(3) Includes food waste in 2002.
(4) This includes roughly 30,000 tons of bulky waste and the balance is mainly MRF residue.

Looking more closely at the results shown in Table 23, Figure 4 illustrates a comparison of the 2017 composition results for the category *Recyclable Paper* (which includes the material categories newsprint, high grade office paper, OCC, magazines and catalogs, mixed recyclable paper and boxboard) against those same material categories in 2012 and in 2002.

Figure 4.
Percentages of Recyclable Paper Found in the Residential and ICI Sector in 2017, 2012 and 2002



There are several conclusions that can be reached when comparing the results from Vermont's current study to the past two studies, even within the limitations discussed above:

- As shown in Figure 4, there is a noticeable decrease in the weight of paper recyclables found in the residential waste stream, starting with an estimated 16.7% of total waste in 2002 and falling to 8.6% in 2017. Tonnage data were not available for 2002 but the estimated decrease in tons of recyclable paper disposed between 2012 and 2017 is significant.
- There is also a significant decline in recyclable paper disposed in the ICI sector between 2012 and 2017 (also shown in Figure 4).
- The steady decline in quantities of recyclable paper (and containers) in Vermont's waste stream over time is reflected in a high overall recovery rate of 72 percent of recyclables, as illustrated in Table E.2 at the beginning of this report.
- The trend of increasing plastics disposed continues, both in Vermont and elsewhere. Because most plastic is so light weight, weight-based sampling continues to show plastic as less of a material disposed when compared to heavier paper and food waste. However, if one were to convert to a

volume-based estimate, it is likely that plastic would be the largest single material disposed in the landfill.[21]

- The trend toward higher quantities of plastic is especially evident in the ICI MSW which exhibited an increase of roughly 9,100 tons, which on a volume basis would be even more significant.
- The estimated amount of residential food waste disposed is not significantly different in 2017 when compared to 2012, but with less residential MSW being disposed overall, food waste becomes a higher percentage of MSW disposal. This is a growing trend as other dense materials are removed from the stream (paper, metals, C&D and other wastes) leaving behind food waste as one of the denser materials still present in large quantities.
- The significant estimated increase in ICI food waste is due to both an increase in estimated ICI waste disposed (20,000 tons) and a decrease in other dense materials found in the ICI waste stream, also making food waste a greater percentage by weight on the overall ICI MSW stream.
- In addition to the disappearance of other high weight materials in the waste stream, increasing the percent food waste, it is also the case that there has been a marked increase in direct to consumer farm sales[22] which means that food processing wastes that would have occurred at industrial facilities are now occurring at local businesses and households.

[21] DSM is not aware of any recent studies that have documented the volume of materials in landfills, and therefore is basing this conclusion on relatively old data available to DSM from a South African study on material densities and the impact on landfills.

[22] https://www.nass.usda.gov/Publications/Highlights/2016/LocalFoodsMarketingPractices_Highlights.pdf

Appendix A:

Hand Sort Material Definitions

PAPER

1 **NEWSPRINT:** The class of paper chiefly used for printing newspapers – i.e. uncoated ground wood paper, including inserts.

2 **HIGH GRADE OFFICE PAPER:** Paper that is free of ground wood fibers; usually sulfite or sulphate paper; includes office printing and writing papers such as white ledger, color ledger, envelopes, and computer printout paper, bond, rag, or stationary grade paper. This subtype does not include fluorescent dyed paper or deep-tone dyed paper such a goldenrod colored paper.

3 **OCC (OLD CORRUGATED CARDBOARD):** Corrugated boxes or paper bags made from Kraft paper. Uncoated Corrugated Cardboard has a wavy center layer and is sandwiched between the two outer layers and does not have any wax coating on the inside or outside. Examples include entire cardboard containers, such as shipping and moving boxes, computer packaging cartons, and sheets and pieces of boxes and cartons. This type does not include chipboard. Examples of Kraft paper include paper grocery bags, un-soiled fast food bags, department store bags, and heavyweight sheets of Kraft packing paper.

4 **MAGAZINES/CATALOGS:** Paper items made of glossy coated paper. This paper is usually slick, smooth to the touch, and reflects light. Examples include glossy magazines, catalogs, brochures, and pamphlets.

5 **MIXED RECYCLABLE PAPER:** Paper other than the paper mentioned above, which can be recycled. Examples include manila folders, manila envelopes, index cards, white envelopes, notebook paper, carbonless forms, junk mail, chipboard and uncoated paperboard, phone directories, non glossy catalogs, offshore cardboard and deep-toned or fluorescent dyed paper.

6 **BOXBOARD (CHIPBOARD):** Chipboard and uncoated paperboard. Examples include cereal boxes and other dry food boxes, toilet paper and paper towel inner tubes, etc.

7 **BOOKS:** Softcover and hardcover books.

8 **POLYCOATED / ASEPTIC CONTAINERS:** Laminated high quality paper cartons used to store drinks without refrigeration.

9 **COMPOSTABLE PAPER:** Low grade paper that is not capable of being recycled, as well as food contaminated paper. Examples include paper towels, paper plates, waxed papers and waxed cardboard, and tissues.

10 **NON-RECYCLABLE PAPER:** Items made mostly of paper but combined with large amounts of other materials such as plastic, metal, glues, foil, and moisture. Examples include plastic coated corrugated cardboard, cellulose insulation, blueprints, sepia, onion skin, foiled lined fast food wrappers, frozen juice containers, carbon paper, self-adhesive notes, and photographs.

PLASTICS

11 **#1 PET BOTTLES - SUBSORT:** Clear or colored+A1 PET bottles, including "VT" deposit containers. When marked for identification, it bears the number "1" in the center of the triangular recycling symbol and may also bear the letters "PETE" or "PET". The color is usually transparent green or clear. A PET container usually has a small dot left from the manufacturing process, not a seam. It does not turn white when bent. This category is to be set aside for sub-sorting into PET bottles currently marked for deposit (carbonated beverages) and those that could be included under an expanded bottle bill (EBB), which would include water and juice bottles

12 **#1 PET FOOD AND DAIRY BOTTLES AND JARS:** Natural and colored HDPE containers that contained beverages, excluding rice milk, soy milk, milk and dairy. When marked for identification, it bears the number "2" in the triangular recycling symbol and may also bear the letters "HDPE. This category is to be set aside for sub-sorting into bottles marked with the deposit indicia (BB) and those that might be included under and expanded bottle bill.

13 **#2 HDPE BOTTLES - SUBSORT:** natural and colored HDPE containers that contained beverages, excluding rice milk, soy milk, milk and dairy. When marked for identification, it bears the number "2" in the triangular recycling symbol and may also bear the letters "HDPE. This category is to be set aside for sub-sorting into bottles marked with the deposit indicia (BB) and those that might be included under and expanded bottle bill.

14 **#2 HDPE FOOD AND DAIRY:** All HDPE bottles that would not be subject to either the current VT deposit or an expanded deposit, including food bottles, rice milk, soy milk, milk and dairy and laundry detergent bottles.

15 **#3 - #7 BOTTLES - SUBSORT:** Plastic bottles made of types of plastic other than HDPE or PET. Items may be made of PVC, PP, or PS. When marked for identification, these items may bear the number 3, 4, 5, 6, or 7 in the triangular recycling symbol. This subtype also includes unmarked plastic bottles. This category is to be set aside for sub-sorting into BB and EBB categories as described under PET bottles above.

16 **PLASTIC CUPS, TUBS AND LIDS:** All plastic cups, no matter what resin used for drinking beverages including iced coffee, solo cups; and all plastic containers used for food items that are not a bottle or a jar. Examples include yogurt and butter containers, no matter what resin type. Keurig cups are excluded from this category.

17 **BULKY RIGID PLASTICS > 1 GALLON:** Plastic pails, large bottles holding kitty litter and bulk water, and plastic objects other than disposable package items. These items are usually made to last for a few months up to many years. These include 5 gallon pails, and the plastics used in children's toys, furniture, plastic landscape ties; plastic railroad ties, mop buckets, sporting goods, etc. This category does not include agricultural pots which are to be separately sorted.

18 **PLASTIC THERMOFORMS:** Typically clear plastic packaging used for lettuce, berries, deli foods, which is sometimes called a "clamshell", no matter which resin it is. Excludes extruded polystyrene foam (EPS).

19 **PLASTIC FILM POUCHES:** Non-rigid plastic and metalized containers used to package food (including snack foods) and beverages.

20 **FILM - RETAIL BAGS:** All plastic bags used to carry groceries and other items purchased at retail stores.

21 **FILM - ICI WRAP:** Film plastic used for large-scale packaging or transport packaging. Examples include shrink-wrap, mattress bags, furniture wrap, and film bubble wrap.

22 **FILM - GARBAGE BAGS:** Bags made specifically to store garbage. Note that bags containing garbage that were once retail bags should be classified as retail bags once the garbage has been emptied out of them

23 **FILM - OTHER:** All plastic bags that are not retail bags or garbage bags, including bread bags, bags used in cereal boxes, non-metalized chip and snack bags, sandwich bags, dry cleaning bags, etc. and plastic film that is contaminated or otherwise non-recyclable. Examples include painting tarps, food wrappers such as candy-bar wrappers, mailing pouches, bank bags, X-ray film, metalized film including metalized chip and snack bags, and plastic food wrap.

24 **OTHER PLASTIC:** Plastic that cannot be put in any other type or subtype. This type includes items made mostly of plastic but combined with other materials. Examples include auto parts made of plastic attached to metal, plastic drinking straws, produce trays, foam packing blocks, foamed polystyrene (including meat trays), plastic strapping, new plastic laminate (e.g., Formica), vinyl, linoleum, plastic lumber, imitation ceramics, handles and knobs, plastic lids, some kitchen ware, toys, plastic string (as used for hay bales), and CDs.

METALS

25 **ALUMINUM BEVERAGE CANS - SUBSORT:** All aluminum cans containing carbonated beverages and therefore subject to a $0.05 VT deposit, as well as beverage containers made from aluminum as well as aluminum food cans. These will be sub-sorted into BB and EBB categories

26 **ALUMINUM FOIL, PANS & FOOD CANS:** Foil used to protect food made from 100 percent aluminum (not aluminum laminated plastics) and aluminum cooking pans.

27 **FERROUS CONTAINERS:** Rigid containers made mainly of steel, such as food and beverage containers. These items will stick to a magnet and may be tin-coated.

28 **OTHER FERROUS:** Any iron or steel that is magnetic. This subtype does not include "tin/steel containers". Examples include empty or dry paint cans, structural steel beams, boilers, metal clothes hangers, metal pipes, some cookware, security bars, appliances, and scrap ferrous items and galvanized items such as nails and flashing.

29 **OTHER NON-FERROUS:** Any metal item that is not magnetic, as well as stainless steel. These items may be made of copper, brass, bronze, lead, zinc, or other metals. Examples include copper wire, shell casings, and brass pipe.

GLASS

30 **GLASS BEVERAGE BOTTLES - SUBSORT:** All glass beverage bottles. This category will be sorted into three sub-categories - BB, EBB, and all other.

31 **FOOD AND DAIRY GLASS:** All other glass containers containing food, dairy products, or non-food.

32 **PLATE GLASS:** All flat glass used building windows and automotive windows.

33 **OTHER GLASS:** All non-container glass, including, for example Pyrex, Corningware, crystal and other glass tableware, mirrors, non-fluorescent light bulbs, auto windshields, laminated glass, or any curved glass

ORGANIC

34 **FOOD WASTE - CONTAINED IN PACKAGING:** Food material, either loose or not in original packaging, resulting from the processing, storage, preparation, cooking, handling, or consumption of food. This type includes material from industrial, commercial, or residential sources. Examples include discarded meat scraps, dairy products, eggshells, fruit or vegetable peels, and other food items from homes, stores and restaurants. May include the bag or other container holding the food if the bag/container weight is insignificant compared to the contained food.

35 **FOOD WASTE - LOOSE:** Unconsumed packaged food products still in retail or factory packaging. If possible, food should be emptied out of packaging into this bin; the packaging should then be sorted in its appropriate category.

36 **LEAVES, GRASS, & BRUSH >1":** Trees, stumps, branches, or other wood generated from clearing land for commercial or residential development, road construction, agricultural land clearing, storms, or natural disaster; prunings and trimmings, and leaves and grass. Items in this category are larger than 1 inch in size.

37 **LEAVES, GRASS, & BRUSH <1":** Trees, stumps, branches, or other wood generated from clearing land for commercial or residential development, road construction, agricultural land clearing, storms, or natural disaster; prunings and trimmings, and leaves and grass. Items in this category are smaller than 1 inch in size.

38 **PET WASTE:** Dog and cat waste, including cat waste contained in kitty litter

39 OTHER ORGANICS: Organic material that cannot be put in any other type or subtype. This type includes items made mostly of organic materials but combined with other materials. Examples include cork, hemp rope, hair, cigarette butts, full vacuum bags, sawdust, and animal feces.

ELECTRONICS

40 CED CRTS: "Covered Electronic Devices" that contain leaded glass.

41 CED TELEVISIONS & MONITORS, NON-CRT: "Flat screen TVs and Monitors.

42 CED DESKTOP & LAPTOP COMPUTERS: All Computers.

43 CED COMPUTER PERIPHERALS/PRINTERS: All printers and computer peripherals.

44 BANNED, NON-CED ELECTRONICS: All personal digital assistants (PDAs), telephones, personal music players, VCR's, DVD players, electronic game consoles, fax machine, answering machines, digital converter boxes, power supply cords, and stereo equipment.

45 SMALL APPLIANCES: Items such as a microwave or coffee maker typically found in a kitchen or bathroom.

HHW

46 PAINT: Oil and latex based paints.

47 BATTERIES (PRIMARY): Any type of unchargeable battery including household batteries such as AA, AAA, D, button cell, and 9 volt.

48 BATTERIES (RECHARGEABLE): Rechargeable batteries used for flashlights, small appliances, tools, watches, and hearing aids. Also includes lead acid storage batteries most commonly used in vehicles such as cars, trucks, boats, etc.

49 MERCURY THERMOSTATS/THERMOMETERS: Mercury-containing thermostats and switches, including older light switches and automotive switches. Also includes mercury containing thermometers.

50 MERCURY LAMPS: Mercury-containing compact fluorescent lamps (CFLs).

51 MERCURY - OTHER: Other mercury-containing products, such as fluorescent ballasts and some small electronic products.

52 OTHER HHW: All materials typically accepted at a HHW collection day including vehicle automotive fluids, medicines, medical products, poisons, corrosives, flammables, and sharps.

CONSTRUCTION & DEMOLITION (C&D) MATERIALS (In the MSW Stream)

53 DRYWALL / GYPSUM BOARD: Clean, painted and wallpapered sheetrock

54 C & D METAL: HVAC metals, rebar, steel and aluminum framing materials, and other metal typically found in construction and demolition materials.

55 ASPHALT SHINGLES: Roofing shingles containing asphalt.

56 PLYWOOD: Laminated 4' x 8' sheets of wood, or pieces of sheets

57 ORIENTED STRAND BOARD: Constructed wood made from glue and oriented wood pieces

58 ASPHALT, BRICK AND CONCRETE: Pieces of asphalt paving, bricks and concrete.

59 WOOD - PAINTED AND TREATED: Wood that has been painted or stained, and wood that has been treated with a wood preservative.

60 WOOD - CLEAN: Wood that has not been painted, stained, or treated. This category excludes plywood, oriented strand board and fiberboard.

61 OTHER C & D: All other construction and demolition debris, including plastic buckets and film clearly used in the construction process, fiberboard, clay pipe, electrical wire, fixtures, etc.

SPECIAL WASTES

62 TEXTILES AND LEATHER: Includes clothing, fabrics, curtains, blankets, stuffed animals, and other cloth material.

63 RUBBER: Any material made of rubber other than vehicle tires.

64 CARPET AND CARPET PADDING: Flooring applications consisting of various natural or synthetic fibers bonded to some type of backing material. Carpet Padding means plastic, foam, felt, or other material used under carpet to provide insulation and padding

65 DIAPERS / SANITARY PRODUCTS: Includes both baby diapers and adult diapers (cloth and paper/plastic) and women's sanitary pads and tampons.

66 FURNITURE / BULKY ITEMS: Large, hard to handle items that are not defined separately. Examples include all sizes and types of furniture, mattresses, box springs, and base components.

67 TIRES: Any vehicle tire.

68 FINES/DIRT/MIXED RESIDUE: Material passing through a 1/2 inch screen which is not otherwise categorized

69 ALL OTHER WASTES NOT ELSEWHERE CATEGORIZED: Any other type of waste material not listed in any other sort category.

Appendix B:

Castleton Polling Institute Backyard Composting Survey Report

Included Under Separate Cover