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We know what plastics are being recycled, but what's still being tossed out with the trash? A fascinating waste characterization study looks into which plastics are being thrown out, and how recycling programs can react to capture more of the waste stream.

What's in the Can?

By Ted Siegler and Natalie Starr

In June 2012, Vermont Governor Peter Shumlin signed Act 148 – "An act relating to establishing universal recycling of solid waste" into law, which sought to better manage the Green Mountain State's solid waste stream, capturing and recycling more materials from all over the state. But before more materials could be recovered from the waste stream, Vermont decided to find out what was out there to be captured.

As it embarks on an effort to implement Act 148, the State of Vermont's Department of Environmental Conservation (DEC) commissioned a waste composition study of municipal solid waste (MSW) generated within the state. The Association of Postconsumer Plastics Recyclers (APR) also contributed funds for the study in an effort to gain a better understanding of the types of plastics being disposed in the waste stream.

The study was carried out by DSM Environmental Services (DSM) and MidAtlantic Solid Waste Consultants (MSW Consultants). MSW Consultants was responsible for carrying out the solid waste sampling and sorting, while DSM was responsible for overall management of the project and for conducting the plastic sub-sort. The full waste composition study is available on the VT DEC website at www.anr.state.vt.us/dec/. This article summarizes the results of the plastic sub-sort.

The data represent plastics found in the waste stream only, not plastics that are collected for recycling. As such, the data provide information on the types and quantities of plastic that remain in the waste stream that could potentially be available for recycling.

Summary of data collection activities

MSW sampling was carried out over the course of two seasons (August and November 2012), with waste sampling activities occurring at four permitted solid waste transfer stations chosen by VT DEC as representative of Vermont's population. The time periods for sorting were

Sidebar 1

One manufacturer of polylactic acid plastic resin contributed to the cost of rental of the Delta Nu resin identification meter. Ultimately only three pieces of packaging were found to be made up of PLA in all of the plastics sorted, of which one was a thermoform.

chosen to avoid seasons with high yard waste generation which could distort the relative magnitude of the various materials sorted.

A total of 40 residential and 60 commercial waste samples were taken and sorted over the two seasons. The resultant data are considered statistically valid at the statewide level, but not seasonally or by individual transfer station.

The samples were selected randomly from trucks entering the transfer stations during the days of sampling and were recorded as "residential" or "commercial" depending on what the driver reported was collected, with sampling only occurring from loads that were reported to be at least 90 percent residential or 90 percent commercial waste. Load and sample selection followed ASTM standards for waste characterization and was consistent with similar statewide studies carried out by the same consultants in Connecticut and Delaware over the past five years.

The waste was sorted into 10 paper, six metal, three glass, four organic, two household hazardous waste, two construction and demolition debris, three electronics and eight special waste categories. Plastic scrap was sorted into 46 categories as shown in Table 1.

Plastic scrap was sorted by resin identification code if one existed on the piece of plastic. If not, a hand-held DeltaNu resin identification device was used to attempt to identify plastics where no code was visible. The resin identification meter worked well for relatively clean plastic packaging, but often could not identify plastic that was either black or dark green. In these cases, the plastic was categorized as "other" to prevent speculative guesses of material type. Film plastics were not sorted by resin type and were assumed to be polyethylene (PE), although it is recognized that while the vast majority of films found in the residential and commercial waste stream are PE, some films may be another resin.

It should be noted that the VT DEC was interested in the amount of beverage container redemption material being thrown away. As such containers in Table 1 with a "BB" or an "EBB" after them refer to beverage containers covered under the current bottle bill (BB), or beverage containers that would be covered under an expanded bottle bill (EBB) assuming that Vermont's expanded bottle bill would incorporate the same materials as Maine's expanded bottle bill.

Table 1 | Plastic sub-sort categories

No. 1 PET bottles (EBB)	Thermoforms PET
No. 1 PET bottles (BB)	Thermoforms PS
No. 1 PET food and dairy bottles and jars	Thermoforms PVC
No. 2 HDPE beverage bottles (EBB)	Thermoforms PP
No. 2 HDPE beverage bottles (BB)	Thermoforms PLA
HDPE food and dairy and detergent	Thermoforms other
Nos. 3 to 7 bottles (EBB)	Film, retail bags
Nos. 3 to 7 bottles (BB)	Film, other bags
Nos. 3 to 7 bottles non	Film, wrap
Nos. 3 to 7 bottles PP	Film, garbage
Plastic cups PET	Film, other
Plastic cups PP	Film, other metalized
Plastic cups PS	Ag pots PE
Plastic cups Keurig	Ag pots PP
Plastic cups other	Ag pots PS
Tubs and lids PE	Ag pots other
Tubs and lids PP	Pouches new
Tubs and lids PS	Pouches old
Tubs and lids other	Pouches other
Bulky Rigid >1 gallons PE	Other plastic blister
Bulky Rigid >1 gallons PP	Other plastic all other
Bulky Rigid >1 gallons other	Bottles PLA
Bulky Rigid >1 gallons PE buckets	Tubs and lids PLA

Source: DSM Environmental Services, 2012.

Results

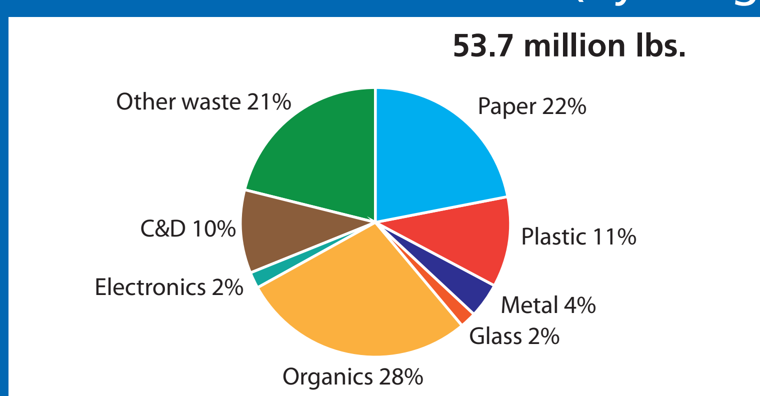
The results of the plastic sub-sort are presented in four ways:

- As a percent of total residential and ICI waste;
- By product type, as a percent of plastic only (total plastic equals 100 percent);
- By resin type;
- By product type within major resins.

Plastic as a percent of total residential and ICI waste

Figures 1 and 2 present plastic as a percent of residential and ICI (industrial, commercial and institutional) waste delivered to transfer stations in Vermont. Each figure also includes DSM's best estimate of how many pounds of plastic that represents being disposed from Vermont communities. The estimate is based on reported transfer and disposal data and

Figure 1 | Plastic as a percent of residential waste (by weight)



Source: DSM Environmental Services, 2012.

an estimate that 60 percent of the total is residential and 40 percent is ICI waste.

As illustrated by Figures 1 and 2, plastic represents 11 and 12 percent, respectively, of Vermont's municipal waste stream, and combined represents an estimated 93.7 million pounds of plastic disposed by Vermonters in 2011.

Composition of plastic waste by product type

Figures 3 and 4 present the composition of plastic waste by product type of the residential and ICI waste. Note that, in this case, each product type is a percent of total plastic, not of total waste including non-plastics.

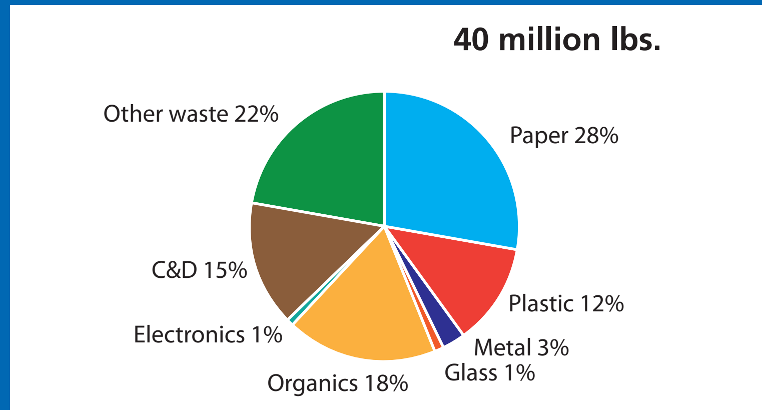
Several important points should be made about Figures 3 and 4. First, product types represented by zero are actually just less than 1 percent. Second, film stands out in both the residential and ICI waste stream as the most significant component of plastic waste in Vermont. Film is probably somewhat over-represented because of the nature of film, which has a high volume-to-surface ratio. Therefore dirt and moisture impact film weights disproportionately compared to rigid plastics. Nevertheless, the large quantities of film indicate that this is a product type with significant potential for increasing the quantity of polyethylene film for recycling, assuming a recycling system for film can be put in place that does not negatively impact materials recovery facility (MRF) operations.

Third, the "other" category is quite high, representing plastic wastes which did not fit the specific categories available. In many cases the other category represented large plastic items such as crates, electronic housings, furniture, plastics from construction and demolition applications, and, in several cases from ICI waste sources, plastic from plastic manufacturing facilities.

Composition of plastic waste by resin type

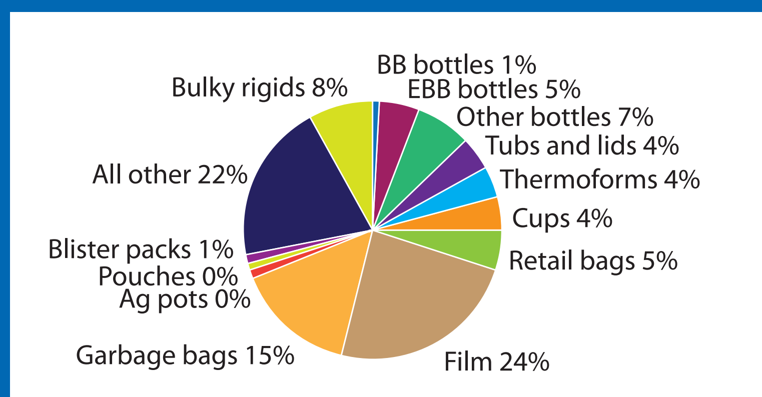
As illustrated by Figures 5 and 6, the composition by resin type more or less mirrors plastic production and use statistics. In both cases, we have made the assump-

Figure 2 | Plastic as a percent of commercial waste (by weight)



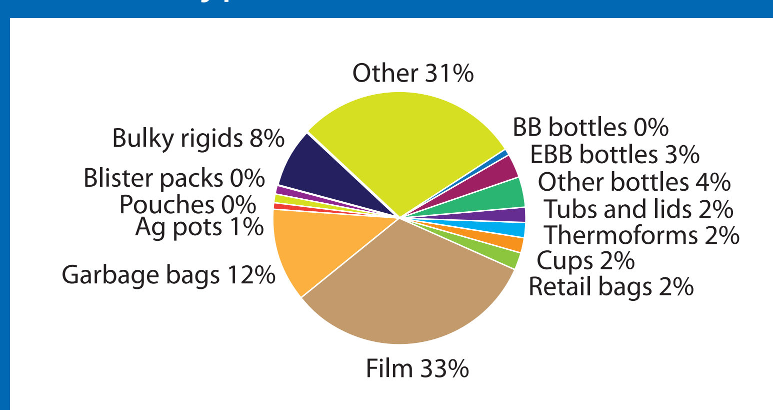
Source: DSM Environmental Services, 2012.

Figure 3 | Composition of plastic by product type residential waste



Source: DSM Environmental Services, 2012.

Figure 4 | Composition of plastic by product type commercial waste



Source: DSM Environmental Services, 2012.

tion that film is polyethylene, although we recognize that some small portion of the film is not PE. However, we did not try to identify the film by resin type.

As was the case in sorting by product type, the "other" category is notably high when sorting by resin. This illustrates one reason why elimination of the resin identification codes, without access to accurate resin identification devices, could negatively impact the ability to identify plastics, both at the MRF, where significant quantities of large rigid plastics are now being processed, and for field studies, such as this one.

Product mix by major resin category

The last set of figures present the product mix by major resin category (HDPE, PET and PP). These figures illustrate what percent of each of these resin types could be potentially recycled under existing recycling programs in Vermont, and where plastic reclaimers might look for additional materials.

As illustrated by Figures 7 through 9, if you are a PET reclaimer, then expanding bottle bills in existing bottle bill states, or implementing bottle bills in non-bottle bill states will yield potentially large quantities of PET bottles. However, if you are an HDPE or PP reclaimer, then a bottle bill and/or an expanded bottle bill will not provide significant quantities of new material. Instead, improving the existing infrastructure to capture additional quantities of materials that are already recyclable will yield the greatest benefits. RR

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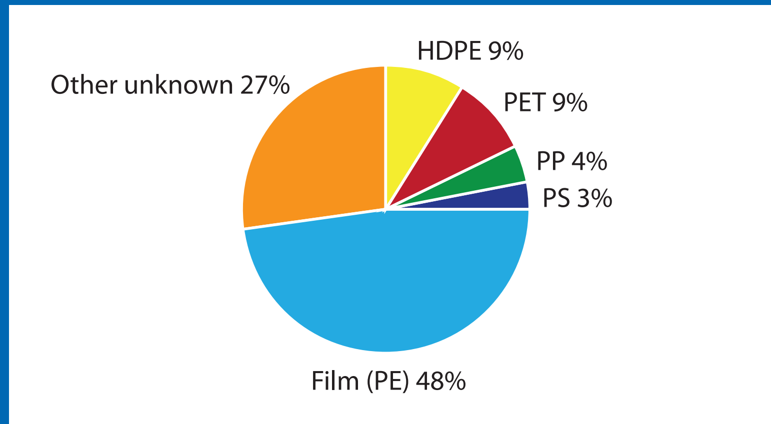
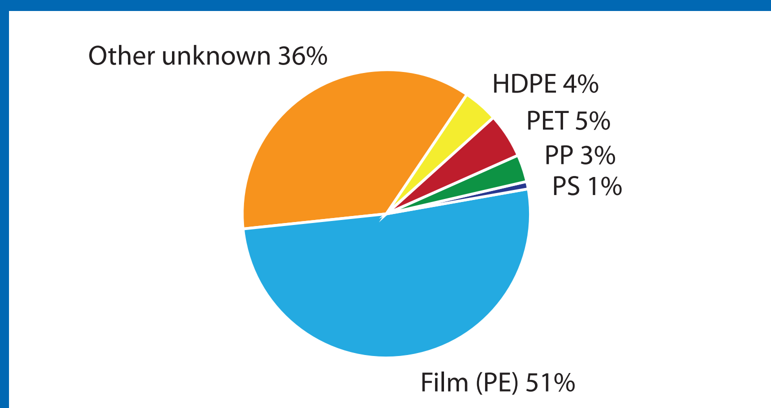
Figure 5 | Composition by resin type residential waste



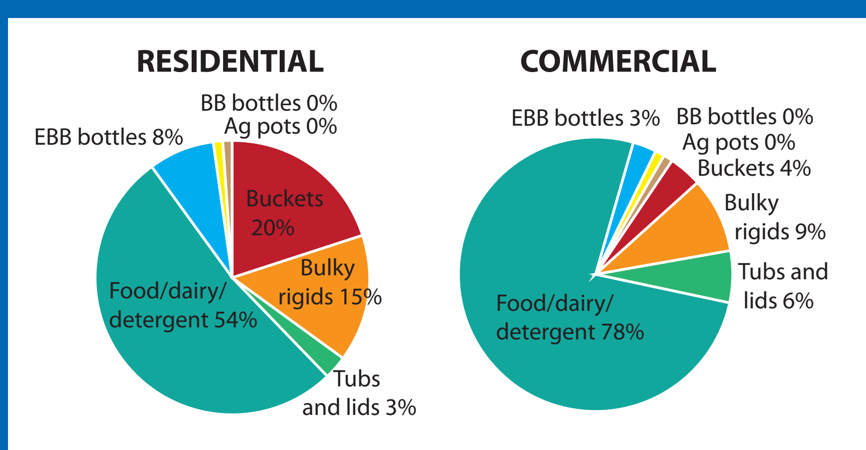
Source: DSM Environmental Services, 2012.

Figure 6 | Composition by resin type commercial waste



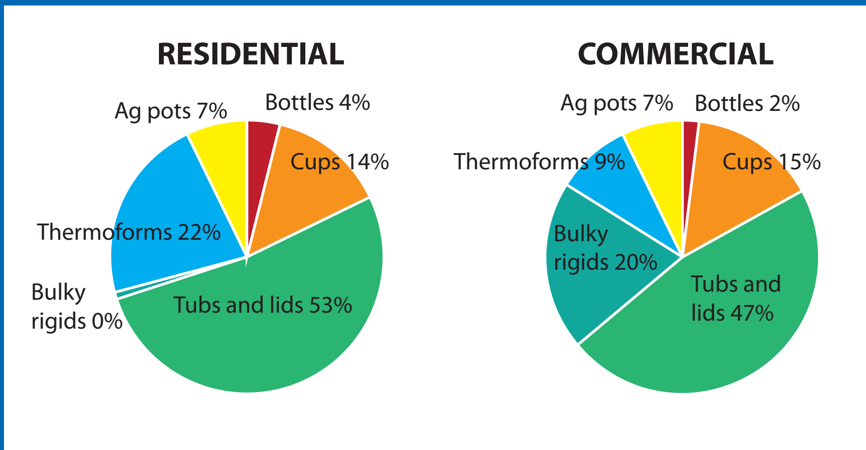
Source: DSM Environmental Services, 2012.

Figure 7 | HDPE



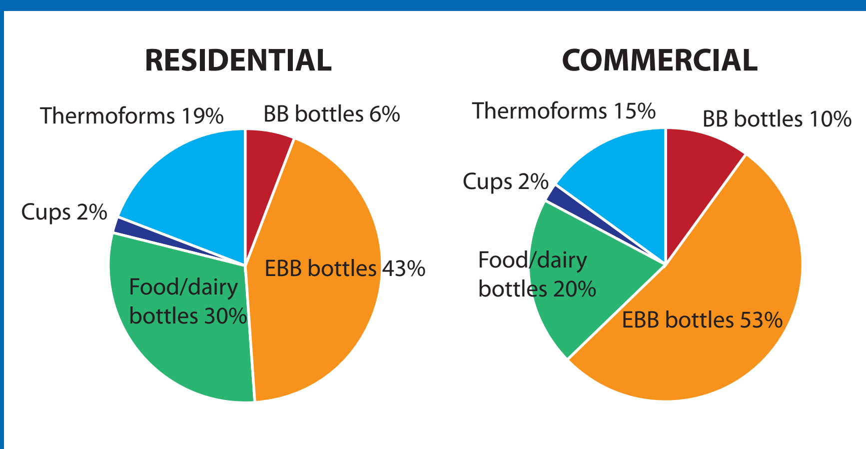
Source: DSM Environmental Services, 2012.

Figure 8 | Polypropylene



Source: DSM Environmental Services, 2012.

Figure 9 | PET



Source: DSM Environmental Services, 2012.