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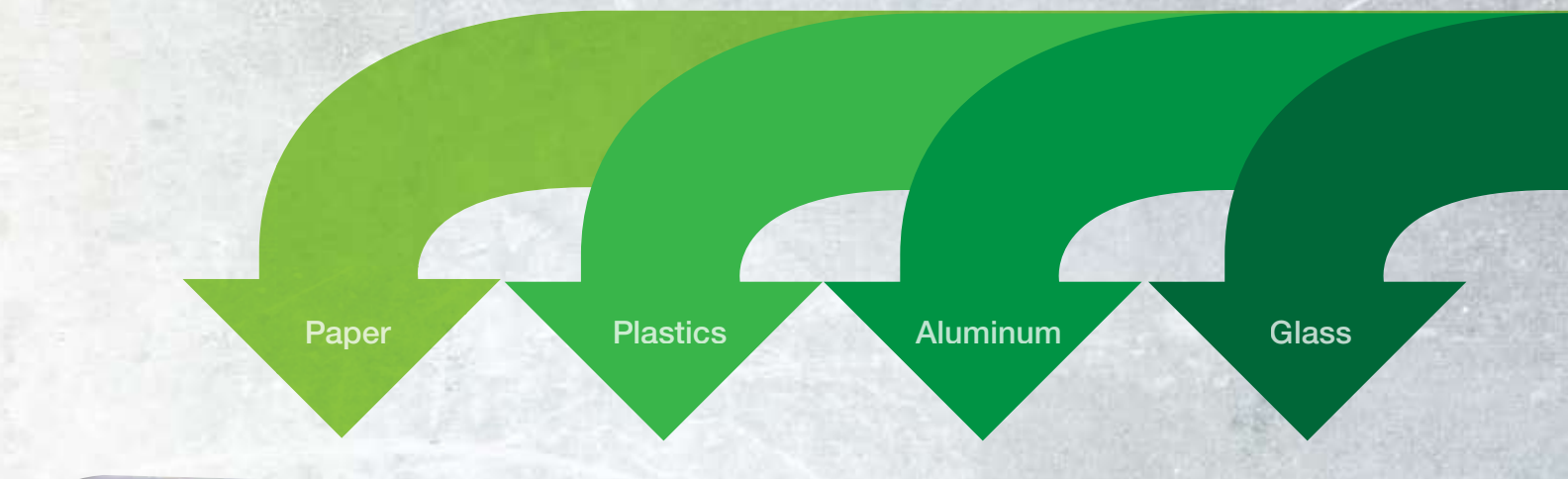
RESOURCE RECYCLING

SINGLE-STREAM UNCOVERED

A new study presents some surprising findings on the economic and environmental impacts of single-stream recycling.

By Clarissa Morawski



Over the past decade, hundreds of communities throughout North America have shifted their municipal recycling collection program from a dual- or multi-stream approach to one that commingles recyclables into one container, due mainly to the convenience factor for residents and costs savings for the local government. However, though municipalities may be switching collection schemes in droves, the success of these programs has been mixed (no pun intended).

For example, volumes may rise with the switch in collection approaches, but many key issues have also been noted from the use of a single-stream collection service, including end-market concerns over product quality – particularly from the fiber end-markets – increased quantities of residues being managed by material recovery facilities (MRFs), and labor and overall processing costs in excess of expectations.

So, in 2008, the Container Recycling Institute (CRI) commissioned Ontario, Canada-based CM Consulting to embark on a research project to examine the economic and environmental impacts of single-stream collection systems. The task involved interviewing recycling executives, city staff and experts, and researching published reports and trade publication articles – including almost two dozen *Resource Recycling* articles dating as far back as 1998 – in order to obtain enough data and information to attempt to qualify and quantify where possible, the impacts. The following results were published in a recently-published CRI report, entitled *Understanding Economic and Environmental Impacts of Single-Stream Collection Systems*.

Rapid growth

Single-stream recycling collection began in California, as municipalities were looking to find a way to increase diversion to meet legislated recycling targets, all while keeping recycling costs down. The existing dual-stream and drop-off mechanisms for collection were not achieving sufficient success, as citizens were not participating enough, education programs were too costly, and collection and processing costs were too high.

For a recycling program to be viable, municipalities require a collection method that yields high participation rates in a cost-effective manner. Because single-stream systems are convenient and simple, recycling rates should increase significantly. On the collection side, the use of a large rollcart allows collectors to automate pick-up from inside the truck cab, and single-compartment trucks save labor and transportation costs. And, with the potential economic savings offered by single-stream collection to haulers, single-

Table 1 | Effects of single-stream on a paper mill

Time period	Feedstock source (as a percent of total incoming material)	Outthrows	Prohibitives	Glass rate	End-market	Pulper yield loss
2001 and prior	Curbside sort (100 percent)	0.25 percent-0.5 percent	0.0	0.0	ONP #8	one percent
2003-2005	Single- or dual-stream (42 percent)	5.7 percent	1.3 percent	0.1 percent	ONP #7, #8	nine percent
Sep.– Dec. 2006	Single or dual-stream (68 percent)	15 percent	3.4 percent	0.33 percent	ONP #8 & #7	N/A

Source: *The Effects of Single-stream on a Paper Mill*, W. Sacia and J. Simmons, 2005

stream collection began to move east.

A July 2005 survey released by R.W. Beck, Inc. found that, in 2000, roughly 11 percent of the U.S. population with access to curbside recycling had single-stream collection. However, by 2007, the American Forest & Paper Association reported that number had increased to 50 percent, with single-stream recycling experiencing a 72.4-percent increase in growth from its 2005 level of 29 percent. And, with each year, hundreds of cities across North America and Europe are shifting to a single-stream collection approach; and it's no wonder, given the benefits single-stream collection is guised to offer.

The dark side: Quality

Unfortunately, processors tell quite a different story about the effectiveness of single-stream collection. In fact, ask any post-consumer materials processor about single-stream collection and it's more than likely they will tell you that handling commingled recyclables is problematic.

In 2005, William Sacia and Jay Simmons published a compelling report, *The Effects of Single-stream on a Paper Mill*, measuring the impacts of residuals on the NORPAC paper mill in Longview, Washington. Prior to 2001, all of the mill's incoming feedstock came from 100-percent source-separated programs, which required an additional 2,500 tons of fiber to replace the rejects. Between 2003 and 2005, the study reported that the mill's input changed dramatically. During that period, roughly 42 percent of incoming secondary newsprint came from commingled (single- or dual-stream) programs and the need for replacement fiber ballooned five-fold to 20,000 tons per year. At the same time, the mill's annual cost base for replacement fiber and disposal increased to $2 million per year. From September 2006 to December 2006, when commingled material increased to 68 percent of the total incoming fiber, outthrows, prohibitives, and glass rates all increased significantly (Table 1).

With the growth of single-stream collection, paper manufacturers have seen their costs escalate. Specifically, these are the additional expenses related to cleaning and screening poorly processed materials, repairing damage to equipment, more frequent equipment cleaning, equipment replacement, buying new raw materials to replace those that were unusable, and disposal of the residual materials that cannot be used.

Sacia and Simmons' report revealed that, prior to receiving commingled materials (from either single or dual-stream collection), the NORPAC paper mill managed the costs associated with maintenance from contamination in their budget, and did not have to spend money to improve incoming material quality. However, in the post-commingling period, from 2004 to the present, the company reported a four-fold increase in maintenance costs related to contamination, as capital investment to improve the quality of incoming material exceeded $100,000.

In a regression analysis from 2004, representatives with the Jaakko Poyry Group and Skumatz Economic Research Associates, Inc. (SERA) interviewed a number of paper mill representatives and extrapolated data on the production costs of new newsprint. Found within the report, entitled *Single-Stream Recycling-Total Cost Analysis*, their findings showed a strong correlation between using recycled content and increased production costs. More specifically, at 100-percent recycled content, there was a cost increase of $6.50 per ton produced.

These results indicate there are significant costs associated with the use of secondary fiber, which creates a disincentive for manufacturers to use recycled materials or to increase recycled content. The analysis further calculates an estimated cost to paper mills if all dual-stream recycling systems were converted to single-stream. The analysis determined that the industry would annually incur an additional $48 to $51 million in costs associated with increased production costs stemming from increased contamination.

In terms of the annual net costs affecting the entire stakeholder group, the analysis done by Jaakko Poyry and SERA shows that, while there is a $10 to $20 per ton (a total savings of $90 to $105 million) average decrease in collection costs for paper products, this would be offset by a $5 to $15 per ton (a total increase of $60 to $70 million) increase in processing costs. Combined with additional papermaking costs of $5 to $13 per ton (a total increase of $48 to $51 million), this resulted in an overall net increase of about $3 per ton (a total increase of $18 to $21 million).

Paper

Assessing the impact on paper quality on the recycling sector is difficult because paper mills receive their secondary feedstock from a variety of suppliers, all of which have different collection methods. It is estimated, however, that for paper pulpers, single-stream material has eight times the yield loss of curbside-sorted material. As Sacia and Simmons conclude, "In the drive to reduce recycling collection costs, the

recovered-fiber-consuming mill has been substantially and adversely affected." There is, they conclude, "a strong need for more balance in the system."

Plastics

Plastics processors report that, in general, material from single-stream MRFs has a yield rate of about 68 percent to 70 percent, compared to dual-stream systems that usually yield about 75 percent to 78 percent. Bales of polyethylene terephthalate from deposit return systems generally have a yield rate of about 85 percent (Figure 1). While a yield differential of five percent to 10 percent may not seem like a lot, consider that if a facility has an annual capacity of 60 million pounds per year (five million pounds per month), every one percent of lost yield represents about 50,000 pounds of new waste, for an average $7,500 loss in value to the processor. MRFs that average just five percent loss in yield, due to poor quality, are losing about $37,500 per month, not including the cost of sending these residuals to disposal.

Aluminum

The aluminum industry reports similar issues associated with single-stream MRFs. Novelis, one of the world's largest aluminum rolling producers and aluminum can recyclers, explained that voluntary supplier action was not yielding measurably improved quality. This was true even during the 2007–2008 commodities boom, during which material revenue and supplier profit far exceeded historical standards. As a result, Novelis implemented a financial penalty for poor suppliers, discounting prices paid by 10 cents per pound.

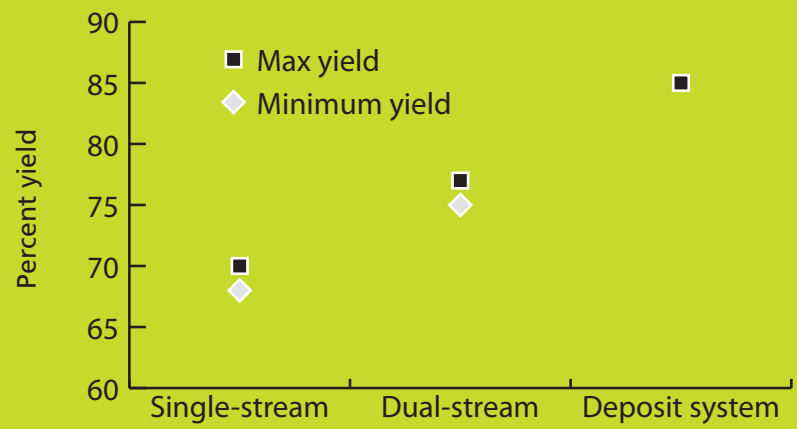
Though it might seem a rigorous measure, the surcharge did not fully compensate Novelis for profit losses, due to low productivity from substandard materials. Recently, a number of suppliers left, and many more have been redirected to a special off-site cleaning facility, where markedly lower prices will be applied to offset the site's operating costs and investment return. Novelis' action highlights how serious the company is about not accepting low-quality material. The company has indicated that other aluminum buyers, such as Alcoa, Inc. and Aleris International, are also serious, and the rest of the industry is coming on-line as well.

Glass

Glass is the material most affected by the approach of a collection system. In single-stream programs, it is virtually impossible to prevent glass from breaking as it goes to the curb, is dumped in the truck, gets compacted, gets dumped on the tipping floor of the MRF, is repeatedly driven over by forklifts, and is dumped on conveyor belts to be processed.

On average, about 40 percent (a range of 20 percent to 60 percent) of glass from single-stream collection winds up in landfills, while 20 percent is small broken glass (fines) used for low-end applications. Only about 40 percent (a range of 20 percent to 60 percent) is recycled into containers and fiberglass. The most likely end-uses for mixed cullet from a MRF is sandblasting base, aggregate material, or alternative daily cover (ADC) for landfills. In contrast, dual-stream systems have an average yield of 90 percent, and container-deposit systems yield 98 percent glass available for use in bottle making (Figure 2).

Figure 1 | Estimated yield rates from collected plastic *



*Based on qualitative information from interviews with plastic end-markets.
Source: Container Recycling Institute, 2008

Economic uncertainty and single-stream

The research for CRI's single-stream report began in the summer of 2008, at the height of nearly a decade of unprecedented economic growth. Crude oil was up over $100 per barrel and demand for secondary feedstock was higher than ever, both domestically and internationally. Strong global demand meant that MRF operators were able to sell to China and other Asian countries. These markets were not concerned with the quality of the materials because cheap labor in these developing countries allowed them to further clean the material. Even in North America, paper mills became significantly less discriminatory about quality because they needed to secure secondary feedstock and were competing with China.

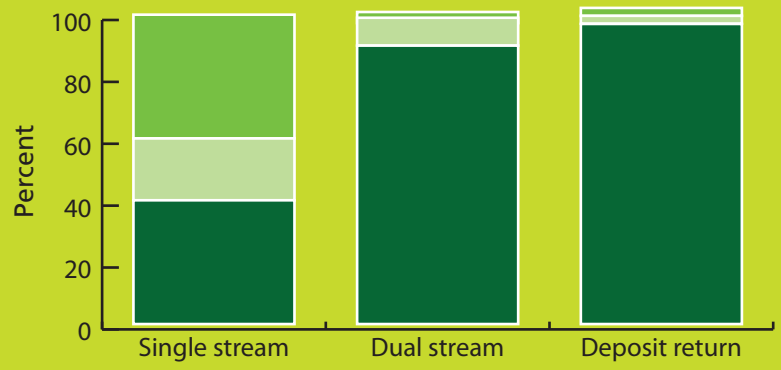
But, by the end of summer 2008, everything changed. I can still remember interviewing a single-stream MRF operator in late October 2008, who explained to me that he could not move most of his fiber material, and that prices for all commodities were dramatically lower than in the previous years. He was looking for warehouse space to store the material until market conditions improved.

The economic collapse of 2008 created an entirely new marketplace, one that has, in effect, tested the single-stream system. The new marketplace enabled processors to discriminate among suppliers, allowing them to choose high-quality feedstock over suppliers whose quality had never achieved the processors' standards in the first place; many of those being single-stream MRFs. Shortly after the economic collapse, Roy Hathaway, head of waste regulation and business waste for the U.K.'s Department for Environment, Food and Rural Affairs, explained that the quality of material would play an increasingly pivotal role in trade, with the market set to face short-term financial constraints. "It is going to be the low-quality end of the spectrum," said Hathaway, "which is going to be squeezed out by an economic downturn."

From an environmental perspective, the key to successful recycling is to keep the material circulating for as many product lives as possible. This is the closed loop

that reduces the need for virgin materials, thus avoiding the energy consumption and greenhouse gas emissions associated with primary materials extraction, transportation and processing. Recycling glass bottles back into bottles, over and over again, is by far the best use of secondary glass, just as it is for aluminum cans. Recycling reduces the need for extraction of raw material, and recycling consumes less energy compared to manufacturing from raw materials. The upstream environmental benefit of recycling materials is 10- to 20-times greater than downcycled.

Table 3 | End-markets for collected glass



Recycled (end-market: Containers and fiberglass)
Glass fines (end-market: Sandblasting, landfill daily cover and road base)
Trash (landfill)

Source: Strategic Materials, Inc., 2009

Similar findings

From an international perspective, CRI's findings seem consistent with other assessments. Last summer, U.K.-based Waste & Resources Action Programme (WRAP) published *Kerbside Recycling: Indicative Costs and Performance*, a report favoring curbside sort on cost, quality and environmental performance. The report disputes the claim that capture rates are higher for commingled even when the contamination is accounted for.

Andy Bond, a U.K.-based MRF operator of both single-stream and curbside sort systems for the past two decades, says, "WRAP confirmed what we have known for several years, namely that there is no evidence to support this [increased recovery], except where the frequency and volume of containment provided restricted material captures in curbside sort schemes relative to commingled. Where equivalent containment is provided, capture rates are comparable."

Today, about one-third of current U.K. curbside programs are single-stream, and many exclude glass. "There is unlikley to be further growth. In fact, we are now seeing a reversal," reports Bond. "Even some of the keenest advocates and larger MRF operators are generally moving to two-stream, and a number of local authorities are switching back to curbside sort."

In Canada, Daniel Lantz, director of environmental and engineering services for Toronto-based Metro Waste Paper Recovery, analyzed recovery rates for three single-stream and four dual-stream programs operating in Ontario. According to findings reported by Lantz in his December 2008 *Resource Recycling* article, entitled "Mixed Results," the weighted averages of recovery increases from 2003 to 2007 were virtually the same for both systems, 6.9 percent and seven percent. Lantz highlighted the fact that increased participation rates may not be solely the result of the collection method; they may also be impacted by other factors that usually come with the introduction of any new recycling program, such as increased promotional efforts, distribution f larger recycling containers to residents, bag limits or user-pay programs for garbage.

The study also found that a drop in collection costs translates to a commensurate rise in processing costs. Lantz concluded that the supposed benefits of single-stream systems over dual-stream do not outweigh their costs. Lantz writes, "In summary, increased processing costs and lost revenues, in total, far exceed collection savings in most instances (and zero under alternating-week collection), overall single-stream recycling does not show the cost advantage that was originally anticipated. As well, the expected increases in capture rate are also not apparent. Overall, dual-stream recycling still appears to be more advantageous."

A chain is only as strong as its weakest link

Susan Kinsella, executive director of Conservatree, and Richard Gertman, consultant/owner of Environmental Planning Consultants, have undertaken a significant amount of work to study single-stream systems, coming up with a series of best practices provided in *Single Stream Recycling Best Practices Implementation Guide, 2007*. When CRI released its report, Gertman contacted CM Consulting, stating, "I believe it possible to do single-stream right – no one is currently doing this, but it could be done. The key is to separate the breakables (glass and ceramics) from the fiber before they are broken at the MRF, instead of intentionally breaking the glass, then trying to sort it all back apart (as is the current practice)." Gertman also added, "The problem is that breakables are crushed at the MRF when the recyclables are both pushed into big storage piles and loaded into the processing system. But, if they are separated first on rubber conveyor belts, then the current processing equipment will produce much cleaner commodities for market."

Applying best practices in any single-stream recycling system is essential for sustainable recycling. Each and every component of recycling, from relationships, communication, education, collection system design, processing system design, contract terms and low-risk sustainable marketing, must be considered equally. If any one component is not properly implemented, the entire system can be compromised.

Moving forward

As we move forward with recycling, the issue of quality is perhaps more important than ever. "With our understanding of the impacts of global warming, we need to refocus on the resource value of recyclables,"

said Gertman. "That means maintaining the quality of the collected materials for use in high-quality products."

Manufacturers of new glass, metal, plastic and fiber products continue to encourage clean collection so that they can use secondary feedstock instead of virgin material for manufacturing. While manufacturers will continue to invest capital into their systems to increase recycled inputs, these investments will remain contingent upon a regular supply of clean material. RR

The report, *Understanding Economic and Environmental Impacts of Single-Stream Collection Systems*, is available at CRI's Web site, www.container-recycling.org.

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