

MIXED RESULTS



Do the advantages of single-stream recycling hold up in a head-to-head comparison? An examination of several single-stream and dual-stream programs tell the tale.

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In 2007, approximately 12 million residents in the province of Ontario, Canada recycled more than 992,070 tons of material – representing about 400 pounds per household. The manner in which these materials are collected and processed varies across the 200 municipalities, but can be primarily broken down into single-stream and dual-stream (fiber and containers) programs.

An ongoing debate in Ontario, and elsewhere in North America, has centered on the relative benefits of single-stream versus dual-stream recycling. While a number of larger municipalities have moved to single-stream recycling, the success of these programs has been mixed. Smaller programs are still undecided on whether or not single-stream is advantageous to consider. Key issues with the program include:

- ◆ Concerns from end-markets over product quality, particularly from the fiber end-markets
- ◆ Increased quantities of residues being managed at the material recovery facility (MRF)

- ◆ Labor and overall processing costs in excess of expectations.

A recent study examined the costs and recovery rates of large-scale recyclables programs in Ontario, including three single-stream and four dual-stream programs.

Collection and processing costs

Comparing program costs across municipalities can be difficult when considering the variances in materials collected and, more importantly, the demographics of each of the programs. For the purposes of the review, the three largest single-stream programs (henceforth, Programs 1, 2 and 3), and the four largest dual-stream programs (henceforth, Programs 4, 5, 6 and 7) were specifically chosen to minimize the variances.

Even at that, the three single-stream programs also are the three largest urban municipalities in the province, with the vast majority of residents living in urban or suburban settings at an average density of 1,235 households per square mile. The dual-

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stream programs, with one exception, have a combination of urban, suburban and rural residents, resulting in an average density of 300 households per square mile.

Table 1 outlines the costs for the three single-stream programs in 2003 and in 2007. In 2003, Programs 1 through 3 were dual-stream programs, and 2007 represents the second full year of single-stream operation. Table 2 presents the costs for the four dual-stream programs over the same period.

Comparing the 2007 results shows that dual-stream programs have a \$3.50 (\$Cdn) lower net-cost per ton. On a cost per household basis, the net cost of single-stream programs is less than \$1 lower.

A number of factors should be noted when comparing the results. First, all of the single-stream programs are operating with new infrastructure. However, some of the dual-stream programs are operating with older technologies that will not be sustainable over the long term – all costs will increase with the establishment of a new infrastructure. The cost increase will be dependent on the processing technologies chosen; however, costs typically would range from \$15 to \$20 per ton for the capital, amortized over 10 years and monetized over 35,000 to 50,000 tons per year.

Additionally, some of this higher capital cost would be offset by lower labor costs, as newer optical-sorting technologies are added to the facility. This development typically saves \$3 to \$5 per ton, again assuming a 35,000- to 50,000-ton-per-year facility, operating over one shift.

The net increase in cost to the dual-stream facilities would be in the order of \$10 to \$17 per ton. Prorating this increase across the facilities that do not have new equipment to the costs for the dual-stream programs shown adds between \$4 and \$6 per ton.

Switching to a single-stream program results in higher labor costs. Based on the level of residue in the inbound stream and the efficiency of the flats/rounds (fibers/containers) separation screens, labor would add between five and eight sorters to a typical dual-stream MRF. This would carry a cost of between \$3 and \$7 per ton.

Secondly, two of the large single-stream programs receive a premium for their fiber. This is something they negotiated with the contractor, who actually buys the fibers from the municipality, and then sells them to the end-markets (i.e., the municipality does not sell directly to the end-market). Across the three programs (only two of which receive a fiber premium), the premium equates to approximately \$6 to \$7 per ton (i.e., comparing programs on an equal revenue stream basis, the dual-stream programs would be \$6 to \$7 per ton lower than indicated).

Next, generally accepted economies of scale associated with recyclables processing must be factored into the mix. With the larger facilities (greater than 50,000 tons per year),

Table 1 Single-stream program costs

Municipality	Quantity (in tons)	2003 ⁽¹⁾		Households	Cost per household	
		Cost per ton			Gross	Net
		Gross	Net		Gross	Net
Program 1	90,643	\$224.00	\$147.66	331,000	\$55.65	\$36.68
Program 2	164,020	\$213.36	\$126.46	959,000	\$33.10	\$19.62
Program 3	51,275	\$241.39	\$141.59	253,700	\$41.41	\$24.29
Average		\$220.99	\$135.21		\$39.30	\$24.05

Municipality	Quantity (in tons)	2007		Households	Cost per household	
		Cost per ton			Gross	Net
		Gross	Net		Gross	Net
Program 1	100,515	\$294.97	\$157.89	377,000	\$71.35	\$38.19
Program 2	182,151	\$269.03	\$130.21	1,066,300	\$41.69	\$20.18
Program 3	81,511	\$276.98	\$148.05	294,000	\$69.66	\$37.24
Average		\$277.91	\$141.84		\$52.86	\$26.97

1. These programs used a dual-stream approach in 2003 and converted to single-stream in 2005. Source: Metro Waste Paper Recovery, 2008.

Table 2 Dual-stream program costs

Municipality	Quantity (in tons)	2003		Households	Cost per household	
		Cost per ton			Gross	Net
		Gross	Net		Gross	Net
Program 4	42,429	\$189.49	\$90.10	177,700	\$41.04	\$19.52
Program 5	33,929	\$283.59	\$162.53	194,200	\$44.95	\$25.76
Program 6	29,737	\$205.59	\$91.57	170,500	\$32.53	\$14.49
Program 7	73,631	\$235.04	\$138.74	321,700	\$48.80	\$28.81
Average		\$228.58	\$123.94		\$43.13	\$23.39

Municipality	Quantity (in tons)	2007		Households	Cost per household	
		Cost per ton			Gross	Net
		Gross	Net		Gross	Net
Program 4	54,944	\$279.13	\$126.26	201,700	\$69.98	\$31.20
Program 5	44,671	\$285.74	\$157.67	204,400	\$56.64	\$31.26
Program 6	39,930	\$265.60	\$122.71	183,300	\$52.49	\$24.25
Program 7	70,816	\$283.65	\$144.37	360,600	\$50.54	\$25.72
Average		\$279.49	\$138.35		\$56.14	\$27.79

Source: Metro Waste Paper Recovery, 2008.

processing typically occurs over more than one shift per day, which monetizes capital costs over two shifts and more tons, thereby lowering the capital cost per ton. Therefore, lower overall operating costs are expected with larger facilities. Monetizing capital over two shifts would reduce capital costs by \$5 and \$8.50 per ton.

Finally, moving to single-stream collection can save collection costs. These savings can be upwards of 20 percent to 30 percent, depending on the level of efficiency of the current collection system. Because the smaller dual-stream programs in the study have much lower population densities, directly comparing the costs is difficult. However, looking at current actual costs shows that the single-stream programs only have a less-than \$3 per ton lower collection cost than the average of the dual-

stream programs collecting two streams in the same pass (two, dual-stream programs use alternating-week collection that mimics single-stream collection).

Considering that dual-stream programs under a higher population density should have even lower collection costs, but that moving to single-stream may save money, the best estimate at this time would be that the dual-stream collection costs could be lowered to match single-stream costs. The range is, thus, set at \$0 to \$3 per ton.

Adding up these additional costs, and the potential savings, the result suggests that dual-stream programs in Ontario, on an equal basis, would have a cost advantage over single-stream programs (see Table 3). Accounting for the differences in the programs, dual-stream programs show an even larger savings, per ton, of between approximately \$8.50

and \$22, or six percent to 15.5 percent, when compared to single-stream programs.

Single-stream's impact on diversion rates

Typically, municipalities that move to a single-stream program report an increase in the quantity of material arriving at the MRF; however, the increase may not be solely due to the single-stream collection system, but rather due to a combination of factors, including increased promotion, bag limits or user-pay system. Overall, no clear evidence indicates that the implementation of single-stream recycling itself is the main basis for increased diversion rates.

Providing more education and promotion to the public clearly will result in an increase in diversion rates. Reminding people of the program, advertising and promoting diversion at work and schools serve to increase diversion through existing programs. However, even with increased public education and promotion, the increase in diversion still relies on voluntary actions on the part of residents.

Anytime a program changes, whether it be to add a bin, add new materials, change the collection system or move to single-stream, a requisite increase in the quantity of material collected at the curb occurs, because the change reminded people about the program.

One of the most effective ways of increasing diversion is to implement a form of restrictive garbage bag/container limits (two or less per week, per household) alone or in combination with reduced collection frequency, and even to a full user-pay system for garbage. Garbage bag limits, and a move to a bi-weekly collection program for garbage, in one large Ontario municipality resulted in a 30-percent to 40-percent increase in recyclables collected curbside. Whether a move to single-stream would actually increase diversion anymore is questionable, as that municipality now is reporting 65-percent diversion, compared to municipalities with bi-weekly garbage collection, plus weekly recyclables and organics collection.

Quantity diverted from single-stream and dual-stream programs

With single-stream recycling, the total quantity of materials arriving at the MRF does, indeed, increase in most instances. However, after accounting for increase in residues, the total quantity diverted may or may not increase. Currently, available data to specifically state that single-stream recycling will result in increased diversion is limited.

The three major municipalities in the province that employ single-stream recycling saw the quantity of recyclables increase by approximately seven percent, per household, between 2003 and 2007 (see Table 4). Over the same period, municipalities employing a

Table 3 Comparison of single-stream to dual-stream costs, with adjustments

	Average quantity (in tons)	Net cost (average)	
		Low	High
Single-stream costs	110,126	\$141.84	\$141.84
Dual-stream costs	47,709	\$138.35	\$138.35
Adjustment for new capital		\$4.00	\$6.00
Adjustment for additional labor		(\$7.00)	(\$3.00)
Adjustment for premium fiber revenues		(\$7.00)	(\$6.00)
Adjustment for economies of scale		(\$8.50)	(\$5.00)
Adjustment for collection efficiencies		\$0.00	\$3.00
Adjustment for two-stream program costs		\$119.85	\$133.35
2007 single-stream to dual-stream difference		(\$21.99)	(\$8.49)
Dual-stream percentage less than single-stream		-15.5%	-6.0%

Source: Metro Waste Paper Recovery, 2008.

Table 4 Recovery rates from Ontario's single-stream recycling programs

Municipality	Households		Quantity per household (in tons)		
	2003	2007	2003	2007	Increase/decrease
Program 1	340,000	377,000	273.8	266.6	-2.6%
Program 2	980,200	1,066,300	171.1	170.9	-0.1%
Program 3	264,400	294,000	189.0	277.2	46.6%
Weighted average			196.1	209.7	6.9%

Source: Metro Waste Paper Recovery, 2008.

dual-stream system increased their recovery rates by the same seven percent (see Table 5). However, the total quantity of material collected per household was about 5.6-percent higher in dual-stream municipalities than under a single-stream program.

One of the larger single-stream programs has a large percentage of their population in multi-family dwellings, which would account somewhat for the lower recovery rate. Recovery rates for Programs 1 to 3 would be expected to have somewhat higher recovery rates, as a result of the large number of large daily newspapers not typically found in the same quantities in the smaller dual-stream programs. This is a factor, considering that recovery rates for newspapers, on average, exceed 90 percent for most Ontario municipalities.

Comparing the data in Tables 4 and 5 suggests no benefit of moving from dual-stream collection to single-stream collection, with respect to the quantity of material that could be diverted from disposal.

Revenue implications

Two factors must be considered when examining the revenue implications of moving to single-stream recycling:

- ◆ Downgrades of #8 newspaper, as a result of poor quality
- ◆ Revenue losses through the inadvertent marketing of prohibitives (plastics, metal, glass and other non-fiber materials)

in the old newspaper (ONP) bale.

The fiber end-markets have been concerned about the quality of fibers coming from single-stream MRFs since they were first introduced more than five years ago. The concern is more about the prohibitives rather than the outthrows (i.e., non-newspaper compatible fibers including old corrugated containers (OCC), old boxboard (OBB) and telephone directories), although outthrows themselves are an issue.

Mills have reported that residue rates/yield losses from single-stream programs average 10 percent to 15 percent, with the worst programs exceeding more than 25 percent. A current estimate from one Ontario mill suggest that the increased prohibitives and outthrows have resulted in a \$20-per-ton increase in processing costs.

The results of these higher yield losses and higher residues have not, to date, been reflected in lower revenues to municipalities for their newspaper. Mill representatives also expressed that, in the near term, the value of fibers from single-stream programs may be downgraded to a "single-stream #8 ONP" and be valued at \$20 per ton less than "dual-stream #8 ONP." Considering that approximately 60 percent of all tons marketed from a MRF are newspaper, this is significant. Across all ONP marketed in Ontario, if all programs moved to single-stream and were downgrad-

ed, the lost revenues would exceed \$8.9 million per year.

Inadvertently, with the high prohibitives rate in single-stream sourced ONP, a lot of valuable material is sent to paper mills. Containers end up going to the fiber mill instead of the respective container end-markets. This means that, although revenues equal to the value of ONP are received for these materials, respecting that containers generally all have higher end-market values than fibers, this is a significant loss in potential revenues.

Using just five percent as the average prohibitives percentage in single-stream sourced #8 ONP, which is about the average, and assuming that the mix of materials lost is equal to the average mix of containers marketed by Program 6 (as an example), the implications on lost revenues would be significant (see Table 6).

Based on the above standards, in total, almost \$115,000 would be “lost” per year; this figure assumes that the 945 tons were “sold” as newspapers, and received the average of \$118 per ton, rather than being sold for each material’s true value, at an average real worth of the materials of an estimated \$240 per ton. Extrapolating this across Ontario, the total value of the lost containers would equate to more than \$2.7 million per year. Making matters worse, fiber mills in the province indicate that they do not recover any material from the pulpers, but rather all rejected materials go to landfill. Thus, the real recovery rates for recycling programs in Ontario are lower than being reported.

Single stream in the future

One Ontario MRF recently installed optical-sorting systems on their fiber lines, in hopes of improving the quality of the ONP being sent to end-markets, as well as reducing sorting staff requirements. In initial pre-installation material audits, prohibitives and outthrows in an average ONP bale were approximately 13 percent – typical of most single-stream plants.

The end-markets, concerned over rising costs, indicated that, if improvements in product quality were not made, then the facility could expect the price paid for ONP to drop by up to \$20 per ton. The facility, in cooperation with Stewardship Ontario (Toronto), investigated alternatives for improving the quality of the ONP stream, which would help guarantee future market value to the municipality, while decreasing processing costs, with the savings being shared with the municipality.

Investigations were made with optical-sorting equipment suppliers in North America and Europe. Facilities within North America and Europe were visited to examine optical-sorting technologies for fibers. Based on these investigations, the best approach was to not use optical-sorting tech-

Table 5 Recovery rates from Ontario’s dual-stream programs

Municipality	Households		Quantity per household (in tons)		
	2003	2007	2003	2007	Increase/decrease
Program 4	177,700	201,700	174.4	272.4	56.2%
Program 5	194,200	204,400	229.2	218.6	-4.6%
Program 6	170,500	183,300	174.7	217.8	24.7%
Program 7	321,700	360,600	228.8	196.4	-14.2%
Weighted average			207.0	221.5	7.0%

Source: Metro Waste Paper Recovery, 2008.

Table 6 Estimated lost revenue to containers found in ONP

Material	Quantity (in tons)	Value per ton ⁽¹⁾	Lost revenue
Aluminum	45.19	\$2.07	\$84,665
PET	168.65	\$368.00	\$56,304
HDPE	110.23	\$524.00	\$52,400
Steel cans	153.22	\$168.00	\$23,352
Three-mix glass	331.79	\$31.00	(\$9,331)
Tubs and lids	11.02	\$146.00	\$1,460
Mixed plastics	76.06	\$146.00	\$10,074
Polycoat/Aseptic	16.53	\$84.00	\$1,260
Polystyrene	9.92	\$75.00	\$675
Plastic film	119.05	\$51.00	\$5,508
Total	1,041.67	\$240.00	\$226,367
Revenue from ONP	1,041.67	\$118.00	\$111,510
Net loss			\$114,857

1. Based on CSR Price Sheet, Average 2007.
Source: Metro Waste Paper Recovery, 2008.

nologies to remove a clean stream of ONP, but rather to use the technology to remove all unwanted materials from the ONP.

The result was the procurement of two, dual-eject optical-sorting machines. The first eject was for prohibitives, including all plastics (film included), metals and glass. The second eject was for all browns, including OCC and OBB. The remaining materials would be negatively sorted and transferred to a short quality-control line, where any missed materials would be removed manually by sorting staff.

Results from the audits after the new equipment was installed show mixed results. The quality of the ONP has improved slightly, with the prohibitives decreasing by more than 50 percent. The total percentage of ONP in the bale increased by approximately one percentage point, while outthrows stayed about the same. The cost to achieve these results has improved, however, with the number of sorters required dropping by more than 50 percent.

As this is the first North American installation of technology intended to manage such a mix of materials, drawing definitive conclusions about its effectiveness is not possible. With the increasing residue rates of the inbound material resulting from a move to closed carts, the optical-sorting machine must sort a much higher percentage of prohibitives and residues.

Overall, ONP product quality has not significantly improved; therefore, the ONP mills’ concerns have not been addressed. Downgrades are still a concern, with resulting decreases in revenue. Ongoing adjustments to the equipment and ongoing audits will ultimately determine its effectiveness at improving fiber quality at a reduced cost. Dual-stream programs typically do not have the same difficulties in meeting ONP market specifications.

The quest for cost-effectiveness

With the collection of recyclables tending to move back to weekly from bi-weekly, as municipalities continue decreasing garbage collection services and the volume of recyclables continues to increase, alternate-week collection systems – with fibers in the first week and containers in the second – provides collection costs similar to single-stream collection (i.e., the cost advantage of single-stream recyclables collection is lost). Therefore, processing single-stream recyclables has to become more cost effective.

An article by Susan Kinsella and Richard Gertman in the August 2007 issue of *Resource Recycling*, “Rethinking Recycling,” summarizes the issues of single-stream recycling in a single line, “Processing facilities, however, have not yet perfected the intricacies of disassembling this mix of materials.” Making

matters worse for Ontario programs is that they collect and process many more materials than are typically managed in U.S.-based programs (e.g., tubs and lids, polycoat, aseptics, plastic film and polystyrene).

Discussions with equipment manufacturers suggest that the efficiency of the front-end processing in a typical single-stream MRF (i.e., separating the fibers from containers) is only about 80 percent to 85 percent. In other words, 15 percent to 20 percent of the fibers end up on the containers line, and 15 percent to 20 percent of the containers end up on the

fibers line. This results in additional requirements for screening and/or sorting staff to clean up and sort the materials to meet end-market specifications. This carries a high cost – higher than doing two sorts at the curb.

Advances in optical-sorting technologies for containers, and more recently fibers, can result in fewer sorting staff and lower overall processing costs, although dual-stream MRFs also can benefit from optical sorting for containers to reduce costs.

In summary, with increased processing costs and the lost revenues in total far exceed-

ing 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 also are not apparent. Overall, dual-stream recycling still appears to be more advantageous.

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