An Evaluation of Optical Sorting of Plastic Resins at the Region of Peel MRF

Submitted to:

Stewardship ONTARIO

and

Region of Peel
Working for you

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Entec Consulting Ltd.

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EXECUTIVE SUMMARY

This study evaluates two alternative optical sorting systems to sort plastics at the Region of Peel's new Material Recovery Facility (MRF). Both of these options were compared against the status quo manual sorting system proposed by Waste Management of Canada Corporation (WMCC) in their tender submission to the Region in July 2003. The tender was awarded to WMCC and at the time of this report, the MRF was in the process of being commissioned.

On the basis of the analysis undertaken (summarized in the following table), labour costs would drop with the reduction from 14 to 3 sorters with optical sorting of mixed plastics (Option 1). An annual revenue of $3,996,604 (or a sales price of approximately $490/tonne) would be required to match the net revenue of the status quo manual sort system. This would drop to 3,287,809 annually (or about $424/tonne) if the Region were to recover aluminum before selling the mixed plastic stream.

Item	Status Quo Manual Sort	Option 1 Mixed Plastics		Option 2 Multi-Sort
		No Alum. Recovery	With Alum. Recovery	
Sorters Required*	14	3	3	8
Labour Cost	$735,000	$157,500	$157,500	$420,000
Annual Material Revenue	($4,383,035)	-	($708,794)	($3,999,051)
Sorting Equipment Annual Cost	-	$190,132	$190,132	$317,798
Additional Equipment Maintenance	-	$14,260	$14,260	$28,520
Disposal of Residue Cost	$21,964	$8,641	$8,641	$20,323
Annual Net Revenue	($3,626,071)	-	($338,262)	($3,212,409)
Annual Revenue Required To Match Status Quo		$3,996,604 ($490/tonne)	$3,287,809 ($424/tonne)	

*total sorters required for plastics, polycoat and asceptic containers

For the multi-sort option (Option 2), the projected annual net revenue is approximately $413,700 less than that of the manual sort (Status Quo) option. The material sales revenue is exceeded by the need for additional quality control sorters and the additional annual cost of the optical sorting equipment. It should also be noted for this option that equipment cost estimates provided by WMCC did not include provision for quality control conveyors and associated supports. Including additional capital costs for this would further reduce the multi-sort annual net revenue.

It is therefore recommended that:

1. The Region obtain firm, updated prices from WMCC and CP for optical sort equipment to sort PET and HDPE, including guarantees for the hit and purity rates.

2. The Region continue discussions with WMCC regarding the option of optically sorting mixed plastics at the Peel MRF. WMCC may wish to give further consideration to the mixed plastic option so as to reduce manual sorting at the MRF, since staffing, training and supervising these sorters requires on-going administrative costs. This study has shown that to be comparable manual sort base case system, the Region would need to receive between $424 and $490/tonne for the product, depending on removal of aluminum.

3. The Region continue to investigate the feasibility or a GTA central processing facility until the economics have been fully assessed.

Acknowledgement

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1.0 INTRODUCTION

1.1 Background

The Region of Peel's new MRF is now being commissioned and will soon be fully operational. Waste Management of Canada Corporation (WMCC) has a contract with the Region to operate the MRF for a minimum of five (5) years. In August, 2005, WMCC approached the Region to discuss the inclusion of optical sorting equipment in the plastics container processing line.

The Region approached Stewardship Ontario's Effectiveness and Efficiency fund to assist with a third party evaluation of the proposed sorting system. Stewardship Ontario subsequently requested that Entec Consulting Ltd. conduct a study to evaluate WMCC's proposal. Following discussions with Regional and Stewardship Ontario staff, it was agreed that the following options for plastics should be reviewed:

- status quo –the present design and proposed operation of the MRF
- Option 1 – optical sorting of mixed plastics, and
- Option 2 – optical sorting of four individual plastic resins.

Both of the sorting configurations proposed by WMCC to Peel Region for these options used CP Manufacturing Inc. (CP) sorting equipment.

Entec submitted a proposal and budget to undertake the proposed work and was authorized to proceed in August, 2005.

This report presents the findings of the review and analysis.

1.2 The New MRF

The new MRF was contracted as a "design/build/operate" single stream facility to handle all of Peel's residential dry recyclables. The MRF was designed to process 35 tonnes/hr, or a maximum of 130,000 tonnes/yr (on 2 shifts, 15 operating hrs/day, 250 days/yr).

1.3 Tender Data

A number of pieces of information contained in the Region's MRF tender have been used in this evaluation. The estimated incoming material composition for the MRF was based on a composition analysis performed in March, 2003 and is presented in Table 2.1. The MRF was designed utilizing CP equipment, however, sorting of plastic containers was

based on positive manual sorting. The anticipated breakdown of container materials assuming maximum MRF throughput after the air classifier (i.e. after glass separation) is outlined in Table 2.2. This information was taken from Peel's MRF tender.

Table 2.1: Estimated Material Composition

Material	Percentage
Newspaper (ONP, inserts)	42.41 %
Cardboard (OCC)	9.70 %
Magazines/Catalogues (OMG)	8.43 %
Boxboard (OBB) and Other Paper	7.10 %
Fine Paper, Writing Paper and Computer Paper	4.23 %
Telephone Books (OTB)	0.46 %
Kraft Paper (brown paper bags)	0.22 %
Green (Coloured) Container Glass	6.55 %
Flint (Clear) Container Glass	5.79 %
Pigmented HDPE Bottles, Jugs and Jars	2.64 %
PET Bottles and Containers	2.54 %
Steel Cans	2.47 %
Film Plastic	1.01 %
Aluminum Containers	0.88 %
Mixed Plastic Tubs	0.76 %
Polycoated Cartons	0.60 %
Natural HDPE Bottles, Jugs and Jars	0.33 %
Polystyrene Foam	0.15 %
Aluminium Foil Trays	0.05 %
Non Recyclable Material	3.68 %
Total	100.0 %

Table 2.2: Estimated Container Throughput*

Materials	Tonnes/yr	Kg/hr
Nat HDPE	429	114
Col HDPE	3,432	915
PET	3,302	881
Mixed Plastics	988	263
Gabletop	312	83
Aseptic	468	125
Aluminum	1,210	323
Residue	459	122
Total	**10,600**	**2,827**

* Container materials remaining after the removal of ferrous cans

The hourly throughput was derived based on a 2 shift, 15 hr/day operation for 250 days/yr. In addition, the tender required bidders to achieve the following recovery rates for containers, on a monthly average, at the MRF:

Material Type	Required Recovery Rate (%)
Aluminum beverage cans	97 %
Aluminum foil containers	93 %
Steel cans	97 %
HDPE	93 %
PET	93 %
Other Plastic Containers (#3, #4, #5, #7)	93 %
Polystyrene Foam	93 %
All Glass (clear, coloured, mixed broken)	95 %
Polycoat/Aseptic Packaging	93 %

Peel's tender requires WMCC to recover 93% of all plastic containers. WMCC is paid a processing fee by the Region for operating the MRF and this fee is adjusted up and down based on actual recovery achieved. The Region retains all revenue from material sales.

2.0 OPTIONS TO BE EVALUATED

2.1 WMCC's Proposal

WMCC's proposal includes two options for consideration:

Option 1 - modifications to the MRF sorting system to provide a single stage of optical sorting of all mixed rigid plastic containers. Bales of the mixed plastics would be shipped to WMCC's CID processing facility in Chicago. Here the bales would be broken and the plastics sorted into individual resin types and further processed.

Option 2 - modifications to the MRF sorting system to provide a 2-stage optical sorting system to separate various grades of plastics that would be marketed from the MRF. The proposed grades include:

- all PET (natural and coloured)
- coloured HDPE
- natural HDPE
- mixed rigid plastic containers

WMCC presented Peel with drawings of the MRF container sorting lines showing the proposed configuration of the Magnetic Separation Systems (MSS) optical sorting equipment, detailed cost estimates including all capital costs for the equipment and associated conveyors, supports, electrical modifications as well as freight and installation charges. Peel was also presented with a spreadsheet summary of anticipated savings and costs associated with each of the options, including such items as labour sorting savings,

disposal tipping fees savings and additional revenue from material sales (assuming higher recovery).

2.2 Entec Options to be Evaluated

The information described in Section 2.1 was forwarded to Entec Consulting and several meetings were held with staff from the Region of Peel and WMCC to discuss details of the sorting options.

It was agreed with Regional staff that this study should be expanded to evaluate other optical sorting equipment and to include an option whereby mixed plastic bales would be shipped to a central plastics recovery facility (PRF) somewhere in the GTA[1], as an alternative to WMCC's CID Chicago plant. Consequently, options to be evaluated as part of this study include:

Option 1 - optical separation of mixed plastics, with bales delivered to either:

- WMCC's CID Chicago plant, or
- a central plastics recovery facility (PRF) in the Greater Toronto Area (GTA)

Option 2 - optical separation of four individual plastic grades:

- all PET (natural and coloured)
- coloured HDPE
- natural HDPE
- mixed rigid plastic containers.

Both of the above options were evaluated against the status quo (base case) of manual sorting of plastics, as originally tendered.

2.3 Selected Optical Sorting Equipment

Although WMCC proposed using MSS equipment, this study will evaluate two other manufacturers, TiTech and Pellenc. Both of these companies have previously been referenced in Ontario studies evaluating optical sorting systems for plastics[2] and both companies cooperated in supplying background data for this project.

Two key pieces of information are critical in evaluating any optical sorting equipment:

[1] Stewardship Ontario has approved The Region of Peel's request for an evaluation of the feasibility of a GTA PRF. This study is presently underway.

[2] MacViro; "Automated paper and Containers Sorting Systems: A Summary of Findings from the Examination of Systems in Selected European MRFs"; for Stewardship Ontario; June 2005
Entec Consulting Ltd.; "A Review of Automated Technology to Sort Plastic and Other Containers"; for EPIC; January, 2003

"Hit rate" - how much actual targeted material is ejected as a fraction of the total targeted material available to be ejected (e.g. a 90% hit rate means that 10% of the targeted material is not properly ejected)

"Purity" - how much of the targeted material ejected is the desired material (e.g. a 92% purity means that 8% of the ejected material is not the target material).

Numerous factors contribute to determining the hit rate and purity of specific optical sorting equipment, including: the speed of the feed conveyor and how well the plastic bottles are spread out on the conveyor; the resolution of the scanner used; the design and cleanliness of the valve blocks used to eject the product; etc. If a given manufacturer achieves an 85% hit rate, then 15% of the desired material is either lost to residue, or requires manual sorting to be recovered. If another manufacturer achieves a hit rate of over 90%, there could be significant annual financial implications. Similarly for purity, additional sorting requirements to upgrade the target material to meet market specifications could prove costly.

One other key consideration is that in a dual eject machine, the second valve block is typically always less efficient than the first, that is, the hit rate and purity for second material is always less than that of the first material ejected.

These impacts will be evaluated more fully in the next section.

3.0 EVALUATION OF OPTICAL SORTING OPTIONS

This section of the report investigates the efficiency, quality control (i.e. manual sorting requirements) and revenue implications of sorting plastics in each of the systems investigated. The full economic impact of each of the systems, including equipment costs, disposal costs, etc. is presented in Section 3.5.

3.1 Status Quo - Base Bid

The status quo option does not involve any optical sorting alternatives for plastics, but relies on sorting the plastics manually, as per WMCC's tender submission. Table 3.1 presents details of this option.

Based on the 93% required recovery rate for the targeted plastic containers, approximately 2,021 tonnes of mixed plastic containers would be recovered annually. Representative manual sorting rates for plastics (shaded blue) were derived from averages achieved at a number of WMCC North American MRFs. Based on the required recovery and sorting rates, it is predicted that 13.3 sorters are required for all of the materials (including gabletop and asceptic), of which 11.2 sorters would be required to positively sort the target plastics. It should be noted that WMCC's tender to Peel stated that ten (10) sorters were required for sorting plastics, polycoat and asceptic.

Based on December material sales prices obtained from Peel Region, the annual projected value of the sorted materials is approximately $4,383,000. Mixed plastics are not manually sorted in this option due to the negative revenue value.

Table 3.1: Status Quo – Base Bid

Tonnes/yr all material	130,000
Operating days/yr	250
Operating hrs/day	15
Annual operating hours	3,750
Tonnes/operating hr	35

Note: indicates data input req'd; indicates target materials

Manual Sort

Materials	Tonnes/yr	Kg/hr Feed	Kg/hr Recovery 93%	Sort Rate (kg/hr)	Sorters Req'd	$Cdn/tonne	Revenue	Rest (kg/hr)
Nat HDPE	429	114	106	180	0.6	$ 820.00	$ 327,155	8
Col HDPE	3,432	915	851	180	5.1	$ 820.00	$ 2,617,243	64
PET	3,302	881	819	160	5.5	$ 468.48	$ 1,438,636	62
Mixed Plastics	988	263	245	90		$ (25.00)		18
Gabletop	312	83		120	0.7	$ 65.33	$ -	83
Aseptic	468	125		90	1.4	$ 65.33	$ -	125
Aluminum	1,210	323					$ -	323
Residue	459	122		200				122
Total	**10,600.0**	**2,827**	**2,021**		**13.3**		**$ 4,383,035**	805

Quantities of each material remaining on the sort line after manual sorting are indicated in the "Rest" column.

3.2 Optical Sorting of Mixed Plastics (Option 1)

Table 3.2 shows details of the proposed mixed plastics optical sort system. The optical sorting system is represented schematically in Figure 3.1. Mixed plastics are ejected from the container stream using a single eject sorter.

In Table 3.2, the quantity of mixed plastics ejected from the feed container stream is governed by the 90% primary hit rate for the sorter, as highlighted by the red box. The purity of the ejected stream is also 90%, meaning that 10% of the ejected material is non-targeted material. The quantities of non-targeted materials ejected have been assumed as proportional to the mix of other non-plastic materials (i.e. gabletop, asceptic, aluminum and residue).

Figure 3.1: Schematic of Mixed Plastics Eject System

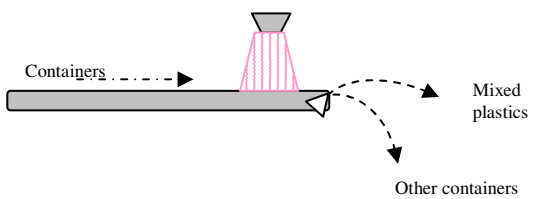


Table 3.2: Mixed Plastics Eject System

						Primary	Secondary						
Tonnes/yr all material	130,000												
Operating days/yr	250				Hit rate	90%	85%						
Operating hrs/day	15				Purity	90%	75%						
Annual operating hours	3,750												
Tonnes/operating hr	35												
Option 1:			**Machine 1**										
Mixed Plastics			**Eject 1**										
Materials	Tonnes/yr	Kg/hr	Mixed Plastics	QC on Product		$/tonne	Revenue	Rest	$Cdn/tonne	Potential	Sort Rate	QC	QC Sorters
			(kg/hr)	Sort Rate	Sorters			(kg/hr)		Revenue	(kg/hr)	Sorters	To Be Used
				(kg/hr)	Req'd								
Nat HDPE	429	114	103	180				11	$ 820	$ 35,178	180	0.1	0.1
Col HDPE	3,432	915	824	180				92	$ 820	$ 281,424	180	0.5	0.5
PET	3,302	881	792	160				88	$ 468	$ 154,692	160	0.6	0.6
Mixed Plastics	988	263	237	90				26	$ (25)	$ (2,470)	90	0.3	
Gabletop	312	83	28	120				**56**	$ 65	$ 13,599	120	0.5	0.5
Aseptic	468	125	42	90				**83**	$ 65	$ 20,295	90	0.9	0.9
Aluminum	1,210	323	107					**215**		$ -			
Residue	459	122	41	200				**82**			200		
Total	**10,600**	**2,827**	**2,174**		**0.0**			**653**		**$ 502,718**		**2.8**	**2.5**
			90%		**1,956**		$ -						

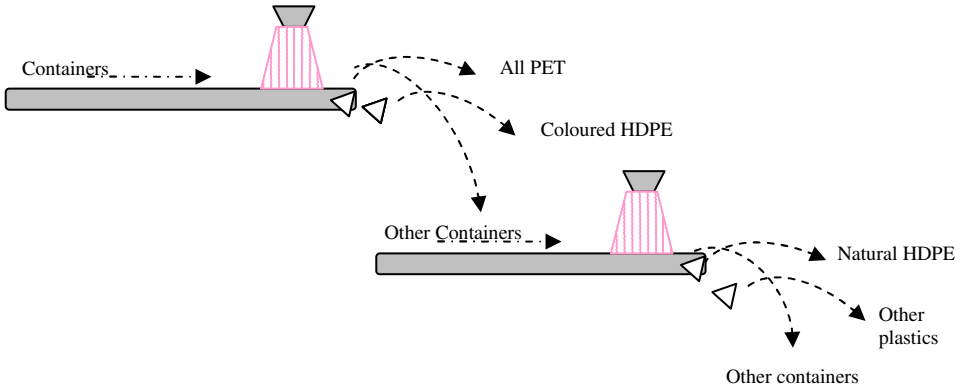
The ejected mixed plastic contains 10% non-targeted materials (i.e. gabletop, asceptic, etc.). WMCC confirmed that they are willing to accept this level of non-plastic material in the mixed plastic sent to their Chicago processing facility, therefore, no quality control (QC) sorters are required. It should be noted that the revenue value of the 107 kg/hr of aluminum alone that is "lost" in the mixed plastics is approximately $708,800.

The "rest" column again indicates the quantity of each material remaining after the optical sort of mixed plastics. It has been assumed that recyclables removed from the ejected mixed plastic stream during quality control (as indicated in blue) are returned to the container line for further sorting. The potential revenue in the remaining material ("rest") and the theoretical number of sorters required to positively sort each material is shown on the right hand side of Table 3.2. The negative value of mixed plastics means that manual sorting is not justified. Sorting of polycoat and asceptic containers is included so as to compare with the base case. The issue of revenues paid for the mixed plastic stream ejected will be addressed in Section 4.0.

3.3 Optical Sorting of Individual Plastic Resins

A schematic of the proposed system to sort individual plastic resins is presented in Figure 3.2. Two dual eject machines would be used. The first would eject all PET at the primary valve and coloured HDPE at the secondary valve. The remaining container stream would then pass through the second machine where natural HDPE would be ejected at the first valve and all other plastic containers at the second. Other containers (e.g. asceptic, aluminum cans, etc.) would continue through the processing system for additional sorting as required.

Figure 3.2: Schematic of Multi-Sort Plastics Eject System



Details of the sorting output are presented in Table 3.3. The analysis approach is the same as in Table 3.2, except that here, two sorting machines are used, each with a dual eject system. As previously discussed, the secondary eject has a lower efficiency than the primary ejection, as highlighted in the red box. For the purpose of this analysis, at the manufacturer's suggestion, the secondary hit rate is assumed at 85% and the purity rate at 75%.

In this system, it is assumed that each of the resins ejected will be marketed locally, therefore, it is important to ensure that each of the ejected material streams meet market specifications that typically require less than 2% by weight of contamination. In Table 3.2, it has been assumed that all non-targeted materials in the ejected plastic streams will require positive manual QC sorting. On this basis, ½ a FTE sorter will be required for quality control on ejected PET and 1.5 FTE sorters for quality control on coloured HDPE. At the second machine, 0.1 sorter is required for quality control for the natural HDPE and 0.5 sorter is required for the mixed plastic stream.

Assuming that all of the non-targeted materials are returned to the system (i.e. not lost to the residue), the potential revenues and number of sorters required are shown for recovering these materials. Since current markets indicate negative revenue for mixed plastics, this separation does not appear warranted. As the revenues column indicates, HDPE warrants consideration of further manual sorting from the "Rest" stream. Polycoat and asceptic are assumed to be manually sorted as per the base case option (for comparison purposes).

For quality control, each of the fractional sorters (0.1, 0.5, etc.) have been rounded up to full sorter requirements, therefore, 8 FTE sorters are required for this option. Total annual material sales revenue for this option is projected at approximately $3,999,000.

Table 3.4: Multi-Sort Plastic Resin Eject System

Tonnes/yr all material	130,000
Operating days/yr	250
Operating hrs/day	15
Annual operating hours	3,750
Tonnes/operating hr	35

	Primary	Secondary
Hit rate	90%	85%
Purity	90%	75%

Option 2: Dual Sort

Material	Tonnes/yr	Kg/hr	Machine 1 Eject 1 All PET (kg/hr)	QC on Product Sort Rate (kg/hr)	QC on Product Sorters Req'd	$/tonne	Revenue	Rest (kg/hr)	Machine 1 Eject 2 Col HDPE	QC on Product Sort Rate (kg/hr)	QC on Product Sorters Req'd	$/tonne	Revenue
Nat HDPE	429	114	5	180	0.0			109	25	180	0.1		
Col HDPE	3,432	915	41	180	0.2			874	743	180		$ 820	
PET	3,302	881	792	160		468		88	20	160	0.1		
Mixed Plastics	988	263	12	90	0.1			252	58	90	0.6		
Gabletop	312	83	4	120	0.0			79	18	120	0.2		
Aseptic	468	125	6	90	0.1			119	28	90	0.3		
Aluminum	1,210	323	15					308	71				
Residue	459	122	6	200	0.0			117	27	200	0.1		
Total	**10,600**	**2,827**	**881**		**0.5**			**1,946**	**990**		**1.5**		
		purity =	**90%**		**792**	**$ 468**	**$ 1,392,229**	**purity =**	**75%**		**743**	**$ 820**	**$ 2,283,873**

	Primary	Secondary
Hit rate	90%	85%
Purity	90%	75%

Material	Rest (kg/hr)	Machine 2 Eject 1 Nat HDPE (kg/hr)	QC on Product Sort Rate (kg/hr)	QC on Product Sorters Req'd	$/tonne	Revenue	Rest (kg/hr)	Machine 2 Eject 2 Plastics	QC on Product Sort Rate (kg/hr)	QC on Product Sorters Req'd	$/tonne	Revenue	Rest (kg/hr)	$/tonne	Potential Revenue	QC Sorters Req'd	QC Sorters To Be Used	Additional Revenue	Total Product Revenue	Total QC Sorters Req'd
Nat HDPE	84	76	180		$ 820		8	7	180				**32**	820	$ 25,955	0.2	0.2	$ 25,955		
Col HDPE	131	1	180	0.0			130	110	180				**62**	820	$ 50,957	0.3	0.3	$ 50,957		
PET	68	1	160	0.0			67	57	160				**31**	468	$ 14,543	0.2				
Mixed Plastics	193	2	90	0.0			192	163	90				**101**	-25	$ (2,515)	1.1				
Gabletop	61	1	120	0.0			61	14	120	0.1			**83**	65	$ 5,435	0.7	0.7	$ 5,435		
Aseptic	92	1	90	0.0			91	21	90	0.2			**125**	65	$ 8,112	1.4	1.4	$ 8,112		
Aluminum	237	2					235	56					**323**	0	$ -					
Residue	90	1	200	0.0			89	21	200	0.1			**122**	0	$ -					
Total	**956**	**84**		**0.1**			**872**	**450**		**0.5**			**879**			**3.9**	**2.6**			**7.6**
	purity =	**90%**		**76**	**$ 820**	**$ 232,490**	**purity =**	**75%**		**337**	**$ -**	**$ -**						**$ 90,460**	**$ 3,999,051**	

3.4 Optical Sorting Equipment Cost

WMCC proposed the use of MSS optical sorting equipment since the MRF was designed with CP processing equipment (CP Manufacturing now owns MSS). MSS had detailed process equipment layout drawings available (through CP Manufacturing) and therefore submitted a detailed quotation for the proposed sorting equipment as outlined in Table 3.4.

Table 3.4: MSS Sorting Equipment Costs

Option 1 - Mixed Plastics

	MSS (US)	MSS (Cdn)	Annual Cost (Cdn)
Capital Cost			
Optical Sorting Equipment	$ 465,200	$ 538,818	$93,118
Steel Package (chutes, hoppers, supports)	$ 120,320	$ 139,361	$24,084
Sub-Total	**$ 585,520**	**$ 678,179**	**$117,203**
Other			
Shipping	$ 15,685	$ 18,167	$ 2,595
Installation	$ 291,740	$ 337,908	$ 48,273
Mechanical and Electrical Engineering	$ 133,330	$ 154,429	$ 22,061
Sub-Total	**$ 440,755**	**$ 510,504**	**$ 72,929**
Total	**$ 1,026,275**	**$ 1,188,683**	**$ 190,132**

Option 2 - Multi Sort

Capital Cost			
Optical Sorting Equipment	$ 968,421	$ 1,121,674	$193,847
Steel Package (chutes, hoppers, supports)	$ 131,725	$ 152,570	$26,367
Sub-Total	**$ 1,100,146**	**$ 1,274,244**	**$220,215**
Other			
Shipping	$ 31,370	$ 36,334	$ 5,191
Installation	$ 390,555	$ 452,360	$ 64,623
Mechanical and Electrical Engineering	$ 167,830	$ 194,389	$ 27,770
Sub-Total	**$ 589,755**	**$ 683,084**	**$ 97,583**
Total	**$ 1,689,901**	**$ 1,957,328**	**$ 317,798**

The right-hand column shows annual cost of the equipment, assuming a 7 year ammortization period at a 5% interest rate. The cost of retrofitting an existing processing system is considerably higher than the cost of designing for the system in a "Greenfield" MRF.

Quotations were requested from both TiTech and Pellenc for both of these options. Each provided budget costs for the optical sorters required but because there were no detailed engineering drawings available (since the MRF has not yet been commissioned and turned over to the Region), detailed comparative costs were not possible.

3.5 Summary Costs

Table 3.5 summarizes total annual costs for the three options evaluated, including projected revenue, labour, disposal cost for the remaining residue, and the supply, installation and maintenance cost of the optical sorting equipment.

Table 3.5: Summary of Sorting Option Costs

		Annual Cost	Option
Manual Sort			
Pounds recovered	16,711,816		
Tonnes recovered	7,580		
Region's revenue	100.0%	$ (4,383,035)	
Sorters Req'd	14		
Labour Cost		$ 735,000	
Tonnes for Disposal	275		
Disposal Tip Fee	$ 80.00		
Disposal cost		$ 21,964	
Total Annual Cost		$ (3,626,071)	
Auto Single Sort			**Recover Aluminum**
Pounds recovered	17,969,695		
Tonnes recovered	8,151		7,748
Region's revenue	100.0%	$ -	$ (708,794)
Additional equipment maintenance		$ 14,260	$ 14,260
Sorters Req'd	3		
Labour cost		$ 157,500	$ 157,500
Tonnes for Disposal	108		
Disposal Tip Fee	$ 80.00		
Disposal cost		$ 8,641	$ 8,641
New Equipment Costs		$ 190,132	$ 190,132
Total Annual Cost		$ 370,533	$ (338,262)
Auto Multi Sort			
Pounds recovered	18,600,954		
Tonnes recovered	8,437		
Region's revenue	100.0%	$ (3,999,051)	
Additional equipment maintenance		$ 28,520	
Sorters Req'd	8		
Labour cost		$ 420,000	
Tonnes for Disposal	254		
Disposal Tip Fee	$ 80.00		
Disposal cost		$ 20,323	
New Equipment Costs		$ 317,798	
Total Annual Cost		$ (3,212,409)	

Labour costs for each of the options were calculated at a base hourly rate of $14/hr (not including overheads) and an annual operation of 3,750 hrs (2 shift operation).

The evaluation shows that the base case (manual sorting as per Peel's tender) results in an annual projected net revenue of about $3,626,000 for the Region, while optical sorting of multiple resins at the MRF is projected to result in a total annual net revenue of approximately $3,212,400.

In the single sort option (Option 1), the labour cost drops dramatically with the reduction from 14 to 3 sorters. Optical sorting of mixed plastics would require an annual revenue of $3,996,604 ($3,626,071 + $370,533) annually, or about $490/tonne of material sold (8,151 tonnes). If the Region were to consider recovering aluminum from the mixed plastic stream before selling the mixed plastics stream, the Region would realize revenue from the sale of aluminum of approximately $708,800/yr (at $1760/tonne). This would mean that the selling price for the remaining mixed plastic stream would need to generate an annual revenue of $3,287,809, or $424/tonne of material sold (7,748 tonnes).

In the multi-sort option, the increased sales revenue is offset by the need for additional quality control sorters and the additional cost of the equipment. The projected annual net revenue for the multi-sort system is $413,662 less than that of the manual sort option. It should be noted, however, that equipment cost estimates provided by WMCC and CP did not include provision for QC conveyors and associated supports. Including additional capital costs for this would further reduce the multi-sort annual net revenue.

4.0 DISCUSSION AND RECOMMENDATIONS

With Option 1 (mixed plastics), the Region would need to sell the mixed plastic stream at a price of about $490/tonne to match the revenue projected for the base case manual sort system. If the Region were to recover aluminum from the mixed plastics prior to selling the mixed plastics, the breakeven sales price would fall to about $424/tonne.

At current sales prices for plastics, projected annual net revenue for the multi-sort system (Option 2) is approximately $400,800 less than that of the status quo manual sort option. It is likely that his gap will increase when additional costs are included to provide the necessary quality control conveyors and associated structures.

One of the key factors in determining the feasibility of optical sorting is the performance guarantees provided by the equipment supplier. As discussed in Section 2.3, the hit rate and purity determine the efficiency and economics of the process. Typically, equipment suppliers will guarantee "safe" or conservative equipment performance and very often, these guarantees are surpassed. For instance, as part of this project, one MRF operator was interviewed to assess optical sorting equipment's actual performance. This operator uses MSS at one of his MRFs (8.5 tons/hr) and TiTech at another (16 tons/hr). He verified that both sorters operate at over 95% efficiency for removal of PET from a mixed container line.

The rates used in Sections 3.2 and 3.3 are considered to be representative guarantees for optical sorting equipment. However, an additional analysis was done to assess the economics of achieving higher hit and purity rates for optical sorting Options 1 and 2. This is shown in the Tables in Appendix A. WMCC claims that they are able to obtain these performance guarantees from the equipment supplier. At the higher efficiencies indicated, the economics of Option 3 improve slightly. For Option 1, 2.1 quality control sorters would be required and the region would require a sales price of either $480/tonne (with aluminum in) or $441/tonne (with aluminum out) to match the projected net revenue of the manual sort system.

For Option 2, 8 sorters will still be required and projected annual revenue would be approximately $3,212,400, or about $413,700 less than the base case.

On the basis of the evaluations conducted, it is recommended that:

1. The Region obtain firm, updated prices from CP for the optical sort equipment to sort PET and HDPE, including guarantees for the hit and purity rates.

2. The Region continue discussions with WMCC regarding the option of optically sorting mixed plastics at the Peel MRF. WMCC may wish to give further consideration to the mixed plastic option so as to reduce manual sorting at the MRF, since staffing, training and supervising these sorters requires on-going administrative costs. This study has shown that to be comparable manual sort base case system, the Region would need to receive between $424 and $490/tonne for the product, depending on removal of aluminum.

3. The Region continue to investigate the feasibility or a GTA central processing facility until the economics have been fully assessed.

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APPENDIX A

WMCC Options

WMCC Option 1

Tonnes/yr all material	130,000
Operating days/yr	250
Operating hrs/day	15
Annual operating hours	3,750
Tonnes/operating hr	35

	Primary	Secondary
Hit rate	96%	85%
Purity	94%	75%

Option 1: Mixed Plastics

Machine 1
Eject 1

Materials	Tonnes/yr	Kg/hr	Mixed Plastics (kg/hr)	QC on Product Sort Rate (kg/hr)	QC on Product Sorters Req'd	$/tonne	Revenue	Rest (kg/hr)	$Cdn/tonne	Potential Revenue	Sort Rate (kg/hr)	QC Sorters	QC Sorters To Be Used
Nat HDPE	429	114	110	180				5	$ 820	$ 14,071	180	0.0	0.0
Col HDPE	3,432	915	879	180				37	$ 820	$ 112,570	180	0.2	0.2
PET	3,302	881	845	160				35	$ 468	$ 61,877	160	0.2	0.2
Mixed Plastics	988	263	253	90				11	$ (25)	$ (988)	90	0.1	
Gabletop	312	83	17	120				**66**	$ 65	$ 16,226	120	0.6	0.6
Aseptic	468	125	25	90				**99**	$ 65	$ 24,216	90	1.1	1.1
Aluminum	1,210	323	66					**257**		$ -			
Residue	459	122	25	200				**97**			200		
Total	**10,600**	**2,827**	**2,220**		**0.0**			**607**		**$ 227,972**		**2.2**	**2.1**
			94%		**2,220**	**$**	**-**						

WMCC Option 2

Tonnes/yr all material	130,000
Operating days/yr	250
Operating hrs/day	15
Annual operating hours	3,750
Tonnes/operating hr	35

	Primary	Secondary
Hit rate	94%	85%
Purity	92%	75%

Option 2: Dual Sort

Material	Tonnes/yr	Kg/hr	Machine 1 Eject 1 All PET (kg/hr)	QC on Product Sort Rate (kg/hr)	QC on Product Sorters Req'd	$/tonne	Revenue	Machine 1 Eject 2 Rest (kg/hr)	Col HDPE	QC on Product Sort Rate (kg/hr)	QC on Product Sorters Req'd	$/tonne	Revenue
Nat HDPE	429	114	4	180	0.0			110	26	180	0.1		
Col HDPE	3,432	915	34	180	0.2			881	749	180		$ 820	
PET	3,302	881	828	160		468		53	13	160	0.1		
Mixed Plastics	988	263	10	90	0.1			254	61	90	0.7		
Gabletop	312	83	3	120	0.0			80	19	120	0.2		
Aseptic	468	125	5	90	0.1			120	29	90	0.3		
Aluminum	1,210	323	12					311	74				
Residue	459	122	5	200	0.0			118	28	200	0.1		
Total	**10,600**	**2,827**	**900**		**0.4**			**1,927**	**999**		**1.5**		
		purity =	**92%**		**828**	**$ 468**	**$ 1,454,106**	**purity =**	**75%**		**749**	**$ 820**	**$ 2,303,637**

	Primary	Secondary
Hit rate	96%	94%
Purity	94%	92%

Material	Rest (kg/hr)	Machine 2 Eject 1 Nat HDPE (kg/hr)	QC on Product Sort Rate (kg/hr)	QC on Product Sorters Req'd	$/tonne	Revenue	Rest (kg/hr)	Machine 2 Eject 2 Plastics	QC on Product Sort Rate (kg/hr)	QC on Product Sorters Req'd	$/tonne	Revenue	Rest (kg/hr)	$/tonne	Potential Revenue	QC Sorters Req'd	QC Sorters To Be Used	Additional Revenue	Total Product Revenue	Total QC Sorters Req'd
Nat HDPE	84	81	180		$ 820		3	3	180				**31**	820	$ 25,209	0.2	0.2	$ 25,209		
Col HDPE	132	1	180	0.0			131	124	180				**43**	820	$ 34,879	0.2	0.2	$ 34,879		
PET	40	0	160	0.0			40	38	160				**15**	468	$ 7,149	0.1				
Mixed Plastics	193	1	90	0.0			192	180	90				**83**	-25	$ (2,076)	0.9				
Gabletop	61	0	120	0.0			61	4	120	0.0			**83**	65	$ 5,435	0.7	0.7	$ 5,435		
Aseptic	91	1	90	0.0			91	6	90	0.1			**125**	65	$ 8,112	1.4	1.4	$ 8,112		
Aluminum	237	1					235	15					**323**	0	$ -					
Residue	90	1	200	0.0			89	6	200	0.0			**122**	0	$ -					
Total	**928**	**86**		**0.0**			**842**	**375**		**0.1**			**825**			**3.5**	**2.5**			**7.5**
	purity =	**94%**		**81**	**$ 820**	**$ 247,551**	**purity =**	**92%**		**345**	**$ -**	**$ -**						**$ 73,635**	**$ 4,078,929**	