City of Hamilton

Review of the City of Hamilton Optical Sorting System

Prepared by:

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Date:

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March 31, 2011

Mr. David Yousif, Project Manager
City of Hamilton
77 James Street North, Suite 400
Hamilton, ON L8R 2K3

Dear Mr. Yousif:

Project No: 60119877-114231

Regarding: Review of the City of Hamilton Optical Sorting System

We are pleased to provide a **"FINAL"** copy of our Optical Sorting System Review Report for the City of Hamilton Material Recovery Facility at 1579 Burlington Street East, Hamilton.

This report summarizes the results and findings for the four (4) monitoring sessions conducted by AECOM. The report also outlines some of the challenges encountered during the execution of the project.

We trust you will find the results of this report beneficial in terms of assessing the overall performance of the Optical Sorting System.

We thank you for the opportunity to carry out this study on your behalf and look forward to working with you on future projects.

Sincerely,
AECOM Canada Ltd.

Dennis Siu, B.Eng., PMP
Mechanical Engineering
Dennis.Siu@aecom.com

DS:mf
Encl.
cc: Ms. Raffaella Morello, City of Hamilton

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1. Background

In 2007, Canada Fibers Limited (CFL) submitted an unsolicited proposal to the City of Hamilton (City) to upgrade the container processing system. The proposed container processing system by CFL was designed to process a minimum of 7 tonnes per hour of incoming commingled container recyclables using a combination of new conveyors and automated sorting equipment. One specific piece of automated sorting equipment outlined in the CFL proposal was Titech's Polysort Optical Sorting System (OSS) that will mechanically recover PET and Mixed Plastic/Aseptic Containers.

To ensure the container processing system proposed by CFL satisfies the facility's current and future operation requirements, the City retained AECOM (formerly Gartner Lee Limited) to conduct a Due Diligence Review on the container processing system. The review, completed in Fall 2007, concluded that the proposed system is complete in all aspects and that it will meet the container processing requirements for the City through to 2017.

In 2009 the City, as part of their project agreement with Waste Diversion Ontario (WDO), decided to review the performance of the Film Grabber System (FGS) and the Optical Sorting System (OSS). As a follow-up to the above noted Due Diligence Review project, the City retained AECOM to perform the assessment on their behalf.

The report that follows is the "City of Hamilton Optical Sorting System Review". The assessment and results of the FGS review is presented in a separate report as requested by the City.

2. Performance Testing Protocol

2.1 Original Performance Testing Protocol

The performance testing protocol set out in the Terms of Reference (ToR) suggested that four (4) monitoring sessions be conducted in: July 2009, September 2009, December 2009 and March 2010. The months were selected to reflect the seasonality of the incoming material stream. Each monitoring session was to include processing four samples of 90 seconds worth of material with the MRF operating at normal throughput speed.

Prior to the commencement of the first monitoring session, a meeting was held between the City, CFL and AECOM to discuss the scope of work, the performance testing protocol and the schedule. During the meeting, CFL suggested that the protocol in the ToR was not practical (given the container processing system design/layout) and that an alternative testing protocol had to be developed. The issue with the existing testing protocol is that the City's container processing system is a closed system (the recovered materials are deposited directly into the designated storage bunker after it has been sorted by the OSS); in addition, there are side skirts on both sides of the OSS quality control conveyors which would not allow the recovered materials to be swept off the conveyor during the monitoring session. The testing protocol described in the ToR is more suited for an OSS installation where the quality control conveyor belt and the conveyor side skirts are at the same height (as in the case for the OSS installed at the City of Toronto Dufferin MRF).

2.2 Revised Performance Testing Protocol

As part of the meeting noted above, an alternative auditing procedure was developed by AECOM, the City and CFL. A summary of the revised testing protocol is outlined below.

1. A single discrete load of approximately 1,000 kg for each monitoring session. The load is collected from random areas on the container tipping floor a day before the monitoring session.
2. Clean out the PET, Mixed Plastic and Residue storage bunkers prior to each monitoring session.
3. Utilize the same number of sort staff required under "normal" processing operations with the exception of the two Quality Control (QC) staff that are typically stationed at the PET and Mixed Plastic conveyor. The QC staff was asked not to perform any material recovery during the monitoring session in order to evaluate the actual performance of the OSS.
4. Record the total time required to process the single discrete load.
5. Record the total weight of materials recovered inside the PET, Mixed Plastic and Residue storage bunker using the floor weigh scale located at the fibre processing area of the MRF. The recovered materials are collected using a white tarp.
6. The materials inside each of the three storage bunkers were then separated by CFL staff into the following categories (see below) and weighed again using either the floor scale or the digital weigh scale provided by the City.
   a) PET;
   b) Thermoform;
   c) Mixed Plastics;
   d) Aseptic/Polycoat; and,
   e) Residue.

Selected photographs taken during the monitoring session are provided below.

Single Discrete Load

Mixed Plastic and PET QC Conveyors

Staff Sorting through the Recovered Material

Material collected inside the PET Storage Bunker

Sorted Material placed in the Plastic Bins **Sorted Material placed in the Plastic Carts**

In addition, it was suggested by WDO (after the first monitoring session) that the recovered Mixed Plastic recyclables be further segregated to determine the composition of the Mixed Plastics. Complying with WDO's request, CFL staff, who assisted AECOM with the auditing process, were instructed to further separate the Mixed Plastic recyclables recovered on the Mixed Plastics/Aseptic conveyor into the following subcategories:

a) HDPE (#2);
b) Polypropylene (#5); and,
c) Other Mixed Plastics.

All of the information listed above was recorded using an audit template prepared by AECOM (see Appendix A).

2.3 Materials Omitted for the Monitoring Session

Similar to other OSS in the market, there are specific materials that are difficult for the OSS to recover. These materials include:

a) Bagged Recyclables;
b) Heavy Items (i.e., bottles that contain a significant amount of liquid);
c) Materials that are stuck together; and,
d) Materials that are covered with ice.

To ensure that the performance of the Hamilton OSS is accurately calculated, the materials listed above were separated from the other recovered materials during each monitoring session and omitted from the data analysis.

2.4 System Monitoring Parameters

For each of the four monitoring sessions, AECOM determined the recovery rate, purity rate and system throughput by analyzing the data gathered at the MRF. A definition of capture rate, purity rate and system throughput is provided below.

1. **Capture Rate** – A measurement of the quantity of items that were successfully recovered by the OSS. This is calculated by dividing the weight of the correctly ejected material by the total incoming weight of the material. For example, if OSS was able to correctly recover 16 kg of PET

out of the total 20 kg of PET available in the inbound material, the capture rate of the OSS will be 80%. The recommended capture rate for the Hamilton OSS is 90-98%.

2. **Purity Rate** – A measurement of the quantity of items recovered by the OSS without mistake. This is calculated by dividing the weight of the targeted material ejected in a given eject by the total weight of the ejected material. For example, if 8 kg out of the total 10 kg recovered in the PET bunker is PET, the purity rate of the OSS will be 80%. The recommended purity rate for the Hamilton OSS is 90-93%.

3. **System Throughput** – The total quantity of material the OSS is capable of processing in an hour. The throughput of the OSS is expressed in tonnes/hour. The recommended system throughput for the Hamilton MRF is up to 7 tonnes/hour.

2.5 System Performance Consideration

It should be noted that there are many operating conditions that can affect the performance and ultimately the capture and purity rate of the Optical Sorting System. These include:

1. **Location of the OSS with respect to the Overall Processing System** – It is safe to assume that the performance of the Optical Sorting System will be lower if it is installed in the middle portion of the overall processing system as opposed to the end. The rationale behind this is that more unwanted recyclables (material that the OSS is not programmed to recover) enter the OSS when it is installed in the middle portion of the processing system and consequently making it more difficult for the OSS to recover the targeted materials. Installing the OSS at the back end of a processing system will most likely yield better recover and capture rates as many of the unwanted materials have been removed at the front end of the processing system.

2. **Throughput of the Processing System** – The throughput (expressed in tonnes/hour) of the overall processing system will have a direct impact on the performance of the OSS. This is because as the throughput increases, the overall quantity (and specifically the burden depth) of material entering the OSS also increases making it more difficult for the OSS to correctly scan and recover the targeted materials. Most OSS requires the inbound material to be flat and spread apart on the infeed conveyor in order to efficiently scan and recover the targeted materials. If, however, the throughput of the overall system is set too high, the inbound materials will have a higher chance of being clustered together and consequently affect the ability of the OSS to recover the targeted materials.

3. **Inbound Material Composition** – The inbound material composition has a dramatic impact on the performance of the OSS. If the system is programmed to recover a material that constitutes a very small percentage of the overall material composition, it will be difficult for the OSS to recover these materials as it will most likely be covered by the other materials. In addition, an OSS installed in a single stream MRF will most likely yield a lower capture & purity rate than an OSS installed in a dual (two) stream MRF. A single stream MRF processes container and fibre materials commingled and therefore a higher quantity of contaminants will enter the OSS and ultimately affect the performance of the system.

4. **Seasonality** – Winter months and spring/fall seasons typically produce inbound materials that are denser, moist and often times stuck together. As indicated earlier, the OSS requires the inbound material to be spread apart on the infeed conveyor otherwise the recovery capability of the system will be compromised. Another drawback to dense and moist material is that the compressed air on the air jet nozzle of the OSS might not have enough pressure to eject the recovered material onto the dedicated QC conveyor. In other words, although the OSS was able to correctly scan the targeted material, the material might still end up on the wrong QC conveyor because it is too heavy (i.e., frozen water bottles) that the OSS cannot eject on to the correct conveyor. During the

summer months and dry seasons, however, the performance of the OSS should increase given that the inbound materials are more likely to be dry and spread apart making it easier for the system to eject the targeted material onto dedicated QC conveyor.

Generally speaking, it is unknown under what operating conditions the recommended capture and purity rates specified by the manufacturers are based on. Through our working knowledge on other OSS related projects, AECOM has noted that the capture and purity rates recommended by the manufacturer is typically higher than what the system is capable of achieving under real operating conditions. The recommended capture and purity rates are most likely determined under ideal operating conditions (i.e., slower system throughput, material composition that contains less contaminant (unwanted material) and more targeted materials, dryer materials) whereas the actual rates achieved by the system are based on operating conditions that are not ideal and will affect the recovery capability of the system. In other words, the discrepancy between the recommended and the actual capture and purity rates achieved by the OSS is most likely a result of the different operating conditions that the system was performing under when tested by the manufacturer and in real operating conditions.

In light of this, it is sometimes misleading to conclude that the performance of the OSS has failed when the calculated capture and purity rate is below the values recommended by the equipment manufacturer as any combination of the four operating conditions presented above can affect the performance of the system.

3. Data Correction

As indicated earlier in the report, the weight of all recovered recyclables was recorded using the either floor weigh scale or the small digital weigh scale. For the first three monitoring sessions, a readout of "zero" was shown when nothing was placed on the scales. During the fourth monitoring session, however, AECOM was told by CFL staff that the floor weigh scale was not giving proper weight readouts and accordingly the staff had to offset the scale readout by "-10 lbs". This issue was brought to AECOM's attention after the single discrete load was already processed, collected and ready to be weighed (the CFL staff had already emptied out the three storage bunkers). In light of this, AECOM decided to continue with the monitoring session based on the assumption that the floor weigh scale was calibrated properly and that the outputted measurements are accurate.

Shortly after the monitoring session, AECOM began the data analysis and determined that a few of the material weight readings were not consistent with the previous monitoring sessions causing the total weight of material recovered in each bunker to be different before and after material sortation. The original numbers recorded during the fourth monitoring session is provided in Table 1.

Table 1. Original Waste Data from the Fourth Monitoring Session

	Original Total Combined Weight Before Sortation (kg)	Original Total Combined Weight After Material Sortation (kg)	Variance
PET Conveyor	121	83	38
Mixed Plastic/Aseptic Conveyor	71	92	21
Residue Conveyor	63	82	19

As shown in the Table 1 above, the total combined weight before and after material sortation did not match. The difference may be a result of the weigh scale not being calibrated properly or, possibly, it was re-calibrated by the MRF operator during the monitoring session.

AECOM presented the data inconsistency to the City. Based on feedback from the Stewardedge, the City recommended that the audit data be re-evaluated to help adjust the data imbalance.

AECOM proceeded with the City's recommendation and calculated the performance of the OSS using a combination of the data from the previous three monitoring sessions as well as the final session. The corrected data for the fourth monitoring session and a comparison with the original data are provided in Table 2.

Table 2. Original vs. Corrected Waste Data for the Fourth Monitoring Session

	Original Total Combined Weight Before Sortation (kg)	*Corrected* Total Combined Weight After Material Sortation (kg)	Variance
PET Conveyor	121	121.03	0.03
Mixed Plastic/Aseptic Conveyor	71	72.59	1.59
Residue Conveyor	63	63.36	0.36

Refer to Appendix B for details on the data correction methodology employed by AECOM.

4. Performance Testing Results

All of the monitoring sessions were conducted on Friday. As explained by CFL, the City's container processing line typically operates from Monday to Thursday which means that Friday is the best available day for the system monitoring. To ensure that the data gathered during each monitoring session is representative of normal operations, CFL confirmed that the staff used during normal processing operation (Monday to Thursday) was used for each of the four monitoring sessions.

The four OSS monitoring sessions took place on:

1. Session 1 – October 9, 2009;
2. Session 2 – December 11, 2009;
3. Session 3 – February 26, 2010; and,
4. Session 4 – April 16, 2010.

4.1 Overall Processing Time

Initially, AECOM was advised by CFL that it will take approximately 15 minutes to process the 1,000 kg sample load and therefore the processing time for the first session was recorded as 15 minutes. However, during the first monitoring OSS session it was noted that the actual time required to process the 1,000 kg was less than 15 minutes. In light of this, it was agreed to (between AECOM and CFL) that the time recording for the monitoring session would commence when the first piece of material was found flowing through the OSS and stop when the CFL Supervisor signals to AECOM that there are no more materials inside the glass trommel screen (located at the front of the processing system). The total time recorded by AECOM will constitute the total time required to process the 1,000 kg sample load. A summary of the overall processing time for the four monitoring sessions is listed in Table 3.

Table 3. Processing Time for each Monitoring Session

Monitoring Session	Date	Processing Time
Session #1	October 9, 2009	15 minutes
Session #2	December 11, 2009	11 minutes 37 seconds
Session #3	February 26, 2010	11 minutes 39 seconds
Session #4	April 16, 2010	12 minutes 39 seconds

4.2 Capture Rate, Purity Rate and System Throughput Summary

The capture rate, purity rate and system throughput calculated for each of the 4 monitoring sessions are summarized in Table 4.

Table 4. Capture and Purity Rate for the Optical Sorting System

	Capture Rate (PET)(A)	Capture Rate (Mixed Plastics/ Aseptic Containers)	Purity Rate (PET)	Purity Rate (Mixed Plastic/ Aseptic Containers)(B)	Machine Throughput (tonnes/hr)
Manufacturer's stated Capture Rate, Purity Rate and Machine Throughput	90-98%	90-98%	90-93%	90-93%	Up to 7 tonnes
Monitoring Session #1	85.0%	84.4%	95.6%	79.5%	0.97
Monitoring Session #2	93.7%	84.4%	97.8%	91.2%	1.24
Monitoring Session #3	83.3%	80.4%	97.2%	79.0%	1.25
Monitoring Session #4	85.1%	79.5%	93.1%	81.1%	1.34
Average for the four monitoring sessions	**86.7%**	**82.1%**	**95.9%**	**82.7%**	**1.20**

Note: (A) The capture rate does not take the PET Heavy found in the mixed plastic/aseptic and residue conveyor into consideration as it is not considered a miss by the system.

(B) The purity rate is based on the total mixed plastic and aseptic containers recovered by the OSS.

A copy of the waste data collected for each of the four monitoring sessions are provided in Appendix C.

4.3 Material Composition for the Recovered Mixed Plastics

As noted earlier, the mixed plastic recovered by the OSS was further segregated to determine the plastic composition. This testing was conducted starting at the second monitoring session. A summary of the plastic composition for monitoring session #2 to #4 is provided in Table 5.

Table 5. Material Composition for the Mixed Plastics Recyclables Recovered on the Mixed Plastics/Aseptic Conveyor

	Material	Monitoring Session #2 Quantity (kg)/Composition	Monitoring Session #3 Quantity (kg)/Composition	Monitoring Session #4 Quantity (kg)/Composition
	Total Mixed Plastics	**33.63 kg (100%)**	**27 kg (100%)**	**33.63 kg (100%)**
Composition	**HDPE**	15.63 kg (46.47%)	10.00 kg (37.03%)	10.00 kg (29.73%)
	Polypropylene	12.00 kg (35.68%)	15.00kg (55.56%)	18.18 (54.05%)
	Other Mixed Plastics	6.00 kg (17.84%)	2.00 kg (7.41%)	5.45 (16.22%)

With the exception of monitoring session #2, polypropylene (i.e., tubs & lids) makes up approximately half of the total mixed plastic recovered by the OSS while HPDE had the second highest composition. This result is in line with the design of the processing system as the recovery of polypropylene at the Hamilton MRF is performed using the OSS (the material is not manually recovered by the sorters). HDPE, on the other hand, is already manually sorted at the container sort station and therefore had a lower composition percentage. The “Other” mixed plastic (recyclables that had a #7 recycling symbol) had the lowest composition in all three tests despite the fact that it is recovered by the OSS only. This result suggests that although solicited as part of the Hamilton Recycling program, the quantity (volume) of #7 plastic in the market is lower than the other plastic types.

4.4 End Market Comment

In order to further validate the performance of the OSS, AECOM contacted the end market for the PET, Mixed Plastic and Aseptic containers and inquired about the quality of bales produced by the City. The end market contacts/information was provided by the City. Below is a summary of the end market’s comments with respect to PET, Mixed Plastic and Aseptic Containers bales produced around the time of each monitoring session.

Table 6. Summary of Comments by the End Market

Monitoring Session	PET			Mixed Plastic and Films
	Ice River Spring	***Plastrec Industries***	***Haycore***	***EFS Plastics***
Monitoring Session #1	No quality issues as the PET bales received from the City are comparable with the PET bales purchased from other Municipalities.	No data are available at the moment.	The end market rated the PET bales received from the City of Hamilton (Rating Scale 1 to 5. Five being the worst.) • Aluminum/Metal contaminant: 3 • PVC contaminant: 3 • HDPE contamination: 4 • Low Melt contamination: 5 • Glass contamination: 2 • Dinginess of bottles: 3 • Other issues: Full of big blue water jugs that we cannot use. The problems with these loads are the low melt trays and lids and the big blue water jugs. There was way too much low melt in these loads. Examples of low melt are items like clear salad trays & lids and clamshell fruit containers for berries, etc.	An audit was conducted by the end market on October 15 on the mixed plastic bales. The results are provided below. • HD-PE, LDPE, PP (54%) • Film (6.5%) • PET/PVC/PS (17%) • Waste (22.5%) This includes metal, aluminum and fibre materials. For film bales, it is estimated that approximately 60-65% is plastic film, 10% is paper, and the rest (25-30%) is metal, aluminum material.
Monitoring Session # 2	No quality issues as the PET bales received from the City of Hamilton are comparable with the PET bales purchased from other Municipalities.	The PET bale contains 18.2% of contaminations (non PET materials).	Currently not receiving PET bales from the City of Hamilton.	An analysis was not done in between the first and second monitoring session.
Monitoring Session #3	No quality issues as the PET bales received from the City of Hamilton are comparable with the PET bales purchased from other Municipalities.	No data are available at the moment.	Currently not receiving PET bales from the City of Hamilton.	Not Available.
Monitoring Session #4	No quality issues with the Mixed Plastic bales produced by the City of Hamilton MRF.	Not Available.	Not Available.	No quality issues with the Mixed Plastic bales produced by the City of Hamilton MRF.

5. Additional Information on the OSS

5.1 Capital Equipment Cost

The overall cost of the new container processing line was in the order of $2.7 million dollars. From that, approximately $573,500 was for the Titech OSS.

5.2 Operation Savings

Overall, the container processing system has resulted in operation savings for both the City and the CFL. The number of sorters required to operate the processing was reduced from 17 sort staff to 11 sort staff after the system upgrade (a 40% decrease).

It should be noted that specifically allocating how much of the staff reduction is attributed to the OSS is not possible at this time. In discussion with CFL, the difficultly arises from the fact that the MRF underwent an entire processing system upgrade (which also included new conveyors, a film grabber and general reconfiguration of the sort process) in which the OSS is only one component of the entire system. In other words, there is no baseline to reference exactly how much sorters are required before and after the OSS installation since the old system was completely different from the new one. If the OSS was added to an existing processing system (as in the case for the City of Toronto Dufferin MRF), the operation savings associated to the OSS can be determined since the overall processing system was not modified.

5.3 Maintenance Requirements

From speaking with CFL, there are very limited amount of maintenance required for the OSS. Staff working at the facility is only required to perform preventative maintenance (i.e., cleaning sensor heads and pneumatic nozzle strip) inside of the OSS to ensure maximum recovery material recovery.

5.4 Health and Safety Issues

There were no health and safety issues related to the OSS observed during the monitoring sessions or reported by CFL. The operation of the OSS can be considered safe and does not present any health and safety risks for staff working on or around the system.

6. Lessons Learned

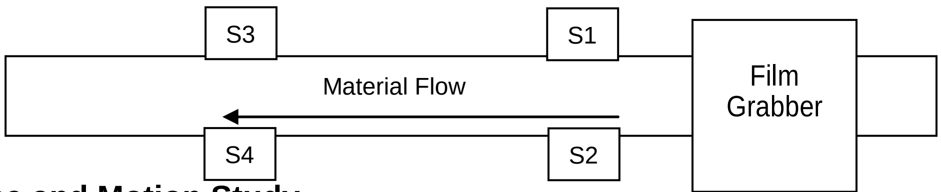
Future testing of the OSS should be MRF and supplier specific. The original testing protocol proposed in the ToR did not take into consideration that not all OSS are designed/configured the same way at the MRF. The original testing protocol was more suited for the OSS at the City of Toronto's Dufferin MRF where the material coming out of the OSS can be easily removed off the conveyor. The testing of the Hamilton OSS, on the other hand, cannot be tested this way as there are side skirts on both sides of the OSS quality control conveyor which prevents the recovered material from being swept off the conveyor during the waste audit (as indicated earlier).

Appendix A

Waste Audit Template

Waste Audit Template (Hamilton Container Process Line)

Date/time:	
Temperature/weather condition	
Location:	
Audit #	
Weight of 1 discrete load:	
Total Processing Time	



Plastic Films Time and Motion Study

Sorter	**Time**	**Quantity**	**Sorter**	**Time**	**Quantity**
S1			**S3**		
S2			**S4**		

Straight from the Designated Bunkers/Film Baler

PET

Plastic Carts/Plastic Bags	Total Weight (kgs)	Weight of Cart (kgs)	Weight of Material (kgs)
1			
2			
3			
4			

Mixed Plastics/Aseptic Containers

Plastic Carts/Plastic Bags	Total Weight (kgs)	Weight of Cart (kgs)	Weight of Material (kgs)
1			
2			
3			
4			

Residue

Plastic Carts/Plastic Bags	Total Weight (kgs)	Weight of Cart (kgs)	Weight of Material (kgs)
1			
2			
3			
4			

Plastic Film

Plastic Carts/Plastic Bags	Total Weight (kgs)	Weight of Cart (kgs)	Weight of Material (kgs)
1			
2			
3			
4			

RECOVERED Material (PET CONVEYOR)

Plastic Carts/Plastic Bags	Total Weight (kgs)	Weight of Cart (kgs)	Weight of Material (kgs)
PET (Bag or Cart)			
1			
2			
3			
4			
5			
6			
7			
8			
THERMOFORM (Bag or Cart)			
1			
2			
3			
Mixed Plastic (Bag or Cart)			
1			
2			
3			
Polycoat (Bag or Cart)			
1			
2			
3			
Residue (Bag or Cart)			
1			
2			
3			
Film (Bag or Cart)			
1			
2			
Other Material #1 (Bag or Cart)			
1			
2			
3			
4			
Other Material #2 (Bag or Cart)			
1			
2			
3			
4			
Other Material #3 (Bag or Cart)			
1			
2			
3			
4			

RECOVERED Material (Mixed Plastic/Aseptic CONVEYOR)

Plastic Carts/Plastic Boxes	Total Weight (kgs)	Weight of Cart (kgs)	Weight of Material (kgs)
TOTAL Mixed Plastic (Box or Cart)			
1			
2			
3			
4			
5			
HDPE # 2 (sub audit)			
1			
2			
3			
4			
5			
PP #5 (sub audit)			
1			
2			
3			
Other Plastics (sub audit)			
1			
2			
3			
Polycoat (Box or Cart)			
1			
2			
3			
4			
5			
6			
7			
PET (Box or Cart)			
1			
2			
3			
Thermoform (Box or Cart)			
1			
2			
Residue (Bag or Cart)			
1			
2			
3			
Film (Box or Cart)			
1			
2			
3			
Other Material #1 (Box or Cart)			
1			
2			

NOTE: the summation of HDPE #2, PP#5 and other plastic should add up to the total Mixed Plastic recovered

RECOVERED Material (Residue)

Plastic Carts/Plastic Boxes	Total Weight (kgs)	Weight of Cart (kgs)	Weight of Material (kgs)
Residue (Box or Cart)			
1			
2			
3			
4			
5			
6			
PET (Box or Cart)			
1			
2			
3			
4			
5			
Thermoform (Box or Cart)			
1			
2			
3			
Mixed Plastics (Box or Cart)			
1			
2			
3			
Polycoat (Bag or Cart)			
1			
2			
3			
Film (Box or Cart)			
1			
2			
Glass (Box or Cart)			
1			
2			
Other Material #1 (Box or Cart)			
1			
2			
3			
Other Material #2 (Box or Cart)			
1			
2			
3			
Other Material #3 (Box or Cart)			
1			

Plastics Film Samples

Bag Sample	Quantity of Bags	Weight of Sample (kg or lbs)

Appendix B

Data Correction Methodology

Appendix B

A summary of the waste data collected during the fourth monitoring session is provided in the table below.

Table A1. Corrected Waste Data for the Optical Sorting System

Targeted Materials	PET Conveyor (kg)	Mixed Plastics/ Aseptic Conveyor (kg)	Residue Conveyor (kg)	Total Quantity of Targeted Material Recovered by the Optical System (kg)
PET Materials				
PET	99.00[(A)]	6.36	11.81	108.17
PET Heavy	0	1.92	10.30	12.22
PET Thermoform	13.64	1.03	0.48	22.51
Mixed Plastics/Aseptic Container Materials				
Mixed Plastics	1.53	33.63	9.28	43.81
Aseptic Containers	0.40	23.63	3.51	27.91
Aluminum	0.11	0.65	1.60	2.36
Residue	6.36	5.37[(B)]	26.38[(C)]	38.11
Total Combined Weight of Material each conveyor (kg)	121.03	72.59	63.36	-
Kilograms per Hour	622.97	373.98	330.55	-

Note: [(A)]*Original weight recorded was 60.91 kg*
[(B)]*Original weight recorded was 19.95 kg*
[(C)]*Original weight recorded was 44.54 kg*

To summarize the table above, all of the data recorded during the fourth monitoring session were consistent with the previous monitoring sessions (and accordingly was not modified for the data analysis) with the exception of the following:

1. **PET Quantity on the PET Conveyor** – The total weight of PET recorded on the PET conveyor was 60.91 kg. This number was significantly lower than the previous 3 monitoring sessions (104 kg, 109 kg and 100 kg). Considering this, AECOM calculated the average net weight of a plastic cart with PET bottles (11 kg) from the first 3 monitoring sessions and multiplied it by the number of plastic carts (9) utilized for the PET material during the fourth monitoring session to get a total weight of 99 kg.
2. **Residue Quantity on the Mixed Plastics/Aseptic Conveyor** – The total weight of residue recorded on the mixed plastic/aseptic conveyor was 19.95 kg. This number was significantly higher than the previous 3 monitoring sessions (5.2 kg, 3.93 kg and 6.98 kg). Considering this, AECOM took the average weight of residue on the mixed plastics/aseptic conveyor from the first three monitoring sessions (5.37 kg) and applied it to the fourth monitoring session.
3. **Residue Quantity on the Residue Conveyor** – The total weight of residue recorded on the residue conveyor was 44.54 kg. This number was significantly higher than the previous 3 monitoring sessions (30.59 kg, 27.40 kg and 21.16 kg). Considering this, AECOM took the average weight of residue on the residue conveyor from the first three monitoring sessions (26.38 kg) and applied it to the fourth monitoring session.

Appendix C

Hamilton MRF Optical Sorting System Composition Audit Data

Hamilton MRF Optical Sorting System Composition Audit

Facility/Address:	Hamilton MRF
Date:	10/9/2009
Time	8:00 AM to 12:00 PM
Condition	Light Rain, 8 degree Celsius
Monitoring Session Number:	1
ple Collection Duration (Minutes):	15 mins
Audit supervisor:	Jake Westerhof
Auditors:	

Conveyors	**PET Material**				**Mixed Plastics/Aseptic Container Material**				**Residue Material**		**Total**		**KG Per Hour**
	PET		**Thermoform**		**Mixed Plastics**		**Aseptic Containers**						
	Weight (kgs)	**Count**	**Weight (kgs)**	**Count**	**Weight (kgs)**	**Count**	**Weight (kgs)**	**Count**	**Weight (kgs)**	**Count**	**Weight (kgs)**	**Count**	
PET Conveyor	104.00	N/A	14.60	N/A	1.00	N/A	0.45	N/A	4.00	N/A	124.05	N/A	496.2
Mixed Plastics/Aseptic Conveyor	3.90	N/A	2.39	N/A	26.76	N/A	17.89	N/A	6.52	N/A	57.46	N/A	229.84
Residue Conveyor	20.54	N/A	2.59	N/A	6.79	N/A	0.00	N/A	30.59	N/A	60.51	N/A	242.04
Total Conveyor	***128.44***	***0.00***	***19.58***	***0.00***	***34.55***	***0.00***	***18.34***	***0.00***	***41.11***	***0.00***	***242.02***	***0.00***	***968.08***

	Capture Rate (PET)	**Capture Rate (Mixed Plastics/Aseptic Containers)**	**Purity Rate (PET)**	**Purity Rate (Mixed Plastic/Aseptic Containers [(A)]**	**Machine Throughput (tonnes/hr)**
Monitoring Session # 1	**85.0%**	**84.4%**	**95.6%**	**79.5%**	**0.97**