Optical Sorting System
Niagara Region

CIF Project No. **161**

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1. Introduction

1.1 Introduction

Niagara Region installed a dual eject optical sorting system in the spring of 2010. The optical sorting system provides three streams of material as follows:

1. PET bottles, jars, trays and clamshells are upwardly ejected
2. Mixed plastics (HDPE, PVC, PP, PS, etc.) are downwardly ejected
3. Polycoat containers and aluminum pass through

The Pellenc technology was installed by Machinex and commissioned in November of 2010 with the assistance of GENIVAR Inc. Appendix A provides additional detail about the Pellenc unit and technology.

Infeed conveyor for Pellenc Optical Sorter

1.2 Project Goals and Objectives

The optical sorter was installed to increase recovery of PET and mixed plastics, increase revenues generated by the plastics stream through capture of quality high-grades of plastic, and reduce labour costs associated with manual plastics sorting.

2. Background

2.1 Community Profile

Known world-wide as both the home of Niagara Falls and as a wine producing region, the Regional Municipality of Niagara (also known as Niagara Region) is comprised of 12 local municipalities: Fort Erie, Grimsby, Lincoln, Niagara-on-the-Lake, Niagara Falls, Pelham, Port Colborne, St. Catharines, Thorold, Wainfleet, Welland and West Lincoln. Geographically, Niagara Region has a total area of 1,852 km^2 and is situated on the Niagara Peninsula, bordered on the North by Lake Ontario, on the south by Lake Erie, on the east by New York State and the Niagara River, and to the west by the City of Hamilton and the County of Haldimand. The population of the Region based on the 2011 Census is 431,346.

Niagara Region reported to Waste Diversion Ontario (WDO) in 2011 (most recent WDO data available) that Blue Box recycling included 166,043 single family residences and apartments with 2 to 6 units, and 24,107 multi-residential units. At that time Niagara Region reported that 40,429 tonnes of Blue Box recyclables were marketed.

Google Maps

2.2 Waste Management System

Niagara Region provides all waste collection, processing and disposal services for residential sector and eligible industrial, commercial and institutional sector for its member municipalities, including

- A weekly two stream recycling collection and processing program. Processing services are contracted to Niagara Recycling
- Weekly organics (Green Bin/Cart) diversion program
- Weekly garbage collection
- Annual HHW events, hosted throughout the Region
- An annual Environment Day for the collection of electronics, scrap metal and tires
- All four landfill/drop off locations, including a privately owned site at Walker Industries, are available to the public serve as recycling centres, where typically the following residential materials are accepted:
    - Tipping fees apply to:
        - Household Waste
        - Scrap Metal
        - Construction and Demolition Materials
        - Appliances containing CFC's
        - Shingles
    - Accepted at no charge:
        - Leaf and Yard Waste
        - Blue and Grey Box Recyclable Materials
        - Tires
        - Electronics
        - Batteries (rechargeable and alkaline)

Niagara Region is also responsible for bylaw enforcement, public education and promotion of the programs offered.

2.3 Current Waste Management Performance

Based on posted 2011 WDO (Generally Accepted Principles (GAP) data for 2011, Niagara Region's diversion rate exceeds 50% of waste generated. Just under 25% of Niagara Region's residential waste stream is recycled through the Blue Box program.

The performance information can be summarized in a table format shown below.

Table 1: Waste Management System Overview for Niagara Region (2011 WDO GAP)

Total Residential Waste Generated		Total Residential Waste Diverted		Total Residential Waste Disposed		Residential Recyclables Diverted	Total Residential Diversion Rate	Total Residential Disposal Rate
Tonnes	Kg/Cap	Tonnes	Kg/Cap	Tonnes	Kg/Cap	%	%	%
187,961.74	420.99	95,003.31	212.79	92,958.43	208.21	24.57%	50.54%	49.46%

2.4 Program Challenges

In April 2009 the Region applied for CIF funding to install optical sorting technology at the Region's Material Recovery Facility (MRF). The main motivation for the installation was to improve the quality and the marketability of the plastic stream, and more specifically to convert the existing low grade mixed plastics into a higher value product by capturing and marketing PET and high grade plastics. At the time of the application the low grade mixed plastic were typically sold at prices ranging from $10 per tonne to negative $25 per tonne. This material consisted of approximately 40% single serve PET, 25% other smaller plastics such as PP, LDPE, HDPE and rigid PS. The remaining 35% was fibre, film, small pieces of EPS and non-recyclable waste.

It was felt that the optical system would recover a projected 800 tonnes of additional PET annually for a revenue of $198,400. It was also expected that 800 tonnes of mixed plastic would be recovered adding to the total revenue gain, which was expected to be $258,400 annually.

Specifically, the primary goals were to:

1. employ optical sorting technology to redistribute low grade mixed plastic into higher value PET and mixed plastic streams, and

2. reduce labour costs associated with plastic sorting.

The labour savings associated with the optical system were expected to be $120,000 annually based on a minimum saving of 3 sorters. Therefore, the total annual gain, being revenues and savings, was projected to be $378,400.

The innovative mesh conveyor system for film and fibre removal will ensure optimum performance of the optical system with minimum quality control and further reduce the amount of low grade material generated to a point where it will become residual waste. The funding request for the mesh conveyor system is $137,740.

The installation of the optical sorting system was also felt to better position Niagara Region to process additional container tonnage from other municipalities on a second shift.

3. Approach

3.1 Set Up and Implementation

As noted before, Regional staff identified a cost/revenue deficiency associated with the management of plastic streams handled by the Niagara MRF. Staff monitor program and operating budgets closely, and also review comparative data posted by WDO to determine and improvements are in order. In the case of managing plastics, given the growing trend in the industry with respect to optical sorting technology for plastics sorting, and the sheer volume of plastic packaging that must be managed for a municipality the size of Niagara region, an RFP was issued for the provision and installation of optical sorting technology, which was to be retrofit into the existing MRF facility on Kent Avenue in Niagara Falls.

As a result of the RFP for the provision and installation of optical sorting technology, the vendor selected was Machinex, which proposed and installed Pellenc technology.

Prior to installation Niagara Region collected marketing data and performed residue audits in order to obtain baseline data on recovery, and more specifically about process losses as relates to plastics. More detail about the baseline data and results of the installation appear in the following section.

The equipment was tested and commissioned by GENIVAR Inc.

3.2 Monitoring and Measurement Methodology

In measuring the impact of the new technology, Niagara Region focused on basic measurements that supported the performance of the equipment: residue audits (material lost at the end of the process, attached as Appendix B) and revenues (a surrogate for both materials gained and product stream improvements).

3.2.1 MRF Residue Audits

The residue audit results are summarized below. Also attached, as Appendix C, is Niagara Region's Audit Procedure.

Results show a distinct drop in the weight of plastics lost to residue following the installation of the optical sorter.

Data in Appendix B shows a gradual increase in the plastics by percent over the period of post-installation audit events; however the actual weight remained low and relatively stable after installation. The main reason for the percentage increase is because a new chute for fibre recovery was installed after the optical sorter was in place. This chute is located just before the optical sorter and enables improved fibre recovery at the facility, capturing fibre that had previously ended up in the residue stream. This is reflected in a noticeable increase in the percentage of plastics residue that is resulting more from a reduction in the size of the overall residue stream than any meaningful increase in the amount of plastics entering the residue stream.

It is noted too that there are some seasonal influences that will drive up plastic residues (Table 2), and these come into play for Niagara as well: influxes of PET that still contain liquid inside and therefore do not blow off the belt properly, and black plastic items that are not detected by the technology, such as flower pots and planting trays.

Table 2: Average kilograms per audit event of recyclable plastics in the residue stream, Niagara Region

kg	Auditing Period
106.5	Prior to Installation
24.1	Test - October, November and December of 2011
29.9	Test - January, February and March of 2012
31.4	Test - April, May and June of 2012
38.7	Test - July, August and September of 2012

3.2.2 Recovery and Revenue

Table 3, below, demonstrates the revenue and recovery improvements resulting from the installation of the optical sorting unit at the Niagara MRF. As revenue comparisons are subject to commodity price fluctuations, a range for increased revenues for PET and High-Grade Mixed Plastics is offered. Of significance is the increase in tonnes sold, for both PET and High-Grade mixed plastics. Figures are based on tonnes shipped to market by the Region for the baseline year of 2009 and the post-installation years of 2011 and 2012.

Table 3 – Niagara Region Revenue Performance, Plastics, Pre and Post Optical Sorter

	PET Bottles			Hi-Grade Mixed Plastics		
Material	Tonnes Sold	Total Revenue	Revenue Per Tonne	Tonnes Sold	Total Revenue	Revenue Per Tonne
2009 Pre-Optical	718	$ 180,068	251	1,188	$ 24,713	21
2011 Post- Optical	1,698	$ 1,023,874	603	2,341	$ 84,888	36
2012 Post-Optical	1,709	$ 734,645	430	2,686	$ 80,989	30
Net Change from 2009 vs 2012	991	$ 554,577	352	1,498	$ 56,276	15
Percentage Increase	138%	308%	71%	126%	228%	45%

3.2.3 Monitoring Challenges, Limitations and Solutions

The main metrics for measurement for this project did not present any unusual challenges. Records for material recovery and sales are tracked as part of the day-to-day management of the facility, and readily available for year to year comparison. Systems are in place to manage and report this data annually to the WDO. The residue audit procedure is clear and replicable.

4. Project Results and Analysis

4.1 Project Results and Analysis

Niagara Region installed and commissioned a dual eject optical sorting system in the spring/summer of 2010, and this system is now an integral component of the Niagara MRF and recyclables processing system. In operation, the system has met or exceeded expectations for material recovery and revenue generation, although expectations for labour reduction have not been realized.

As previously noted, residue audits post-installation revealed that plastics losses in residues have also been reduced. In general, the installation of optical sorting has resulted in the following:

- Improved overall capture of plastics
- Improved streaming of higher value plastics to maximize revenues

With respect to labour savings, Niagara Region was not able to demonstrate a reduction in labour. Additional information about this aspect will be discussed in Section 4.2.

The original overall project budget before taxes was $2,061,412 with an expected annual savings to the Region (labour savings and revenues) of $378,000. Based on CIF funding of $595,855 the payback to the CIF was estimated to be 1.6 years, however based on actual revenues payback was just under a year. The Region also obtained $1,185,000 from Ontario's Municipal Infrastructure Investment Initiative, reducing the Region's portion of the cost to $280,557 and the payback to the Region for its portion of the expenditure based on revenues was about 5.3 months.

Revenue gains realized by the Region in 2011 are shown in the table below, accounting for actual tonnages, market conditions and revenues in 2011:

Table 4 – 2011 Revenues Attributed to Optical Sorting Installation, Niagara Region

Scenario	PET Revenues	Mixed Plastics Revenues	Total
Had Niagara not installed OST	$432,954	$42,768	$475,722
Actual Recovery using OST	$1,023,874	$84,888	$1,108,762
Difference	$590,920	$42,120	$633,040

In effect, the optical sorter helped the Region capitalize on a favourable market situation for PET and high-grade mixed plastics, further enhancing the value of the installation and reducing the pay-back period.

In 2011 the Region of Niagara introduced important service level changes, and monitored the impact of these changes on collection volumes. These changes, which included moving to weekly collection for both containers and fibres from the previous alternating week system, introducing a waste container set-out limit, and enhancements to the multi-residential recycling service, resulted in a 13% increase in recycling volumes. While likely contributing to the overall improvement in marketed tonnes illustrated in Table 3 above, it is apparent that the installation of the optical sorting technology is the main driver in the significant improvement to plastic recovery in the Region.

Outbound from sorter: high grade mixed plastics (left) and PET (far right) at QC station

4.2 Lessons Learned

There are a number of lessons to be shared by the Region's experience, particularly for those programs which might be considering installing optical sorting technology.

In retrofitting the unit to the Niagara MRF, some materials passing through the optical sorter are incorrectly ejected with the plastic material. Most specifically, the eddy current for aluminum is located downstream of the sorter, and as a result some aluminum is ejected with the plastics. This, among other things discussed below, requires that a QC process be established to retrieve (positively sort) the aluminum capture by the system. Those considering installing optical sorting are encouraged to review their process order and include in their RFP or purchase agreement costs for moving other equipment, such as eddy currents, into positions that precede the optical sorting equipment.

The optical sorting process requires large inputs of air for the air jets to work effectively. In the case of Niagara, the system cannot run if one of the two air compressors is out of service. It is felt that some redundancy in air compressors or air compressor sizing would be helpful. In those instances either a back-up compressor is required or the single air compressor needs to be able to power through minor leaks. Either way consideration for redundancy should be written into the RFP specifications.

Those using optical sorting can expect to go through a learning curve. The system uses a large number of codes to direct staff and operators with respect to operating conditions, calibration and system warnings. Overall the system is fairly sensitive while handling large volumes of material, and municipalities purchasing optical sorting technology may wish to consider including within their RFP for the purchase and installation of OST a request for pricing for a long-term maintenance contract. To this end it is important to consider where service will be offered (i.e. local service) and response times for service. Overall the system requires constant adjustments and daily cleaning of lenses and nozzles.

Facility conditions are also important. For instance, air conditioning for the system is required as temperatures should not exceed 17°C for optimal operation.

Adjustments are also frequently required, and the Region has experimented with different product mixes to get optimal performance from the system. Niagara can adjust the products that are removed by the optical by making simple program changes with the up and down ejects on the touchscreen interface. Jet (nozzle) cleaning procedures are needed on a daily basis using the touchscreen interface.

The installation of the optical sorter did not result in a labour savings as originally proposed. In the case of Niagara, the actual effect was to cause a redistribution of labour functions, mainly by moving individuals at the front end of the process to the back end, as a QC step following the optical sort. The system, based on the powerful air jets that are ejecting plastics, sometimes captures other elements (as per the previous discussion about aluminum) that must be removed. Niagara redistributed some labour from manually sorting PET and mix pre-optical to new locations post-optical which include QC stations both before and after the optical unit to remove problem materials such as fibre, film, residue and aluminum foil products.

Niagara reports that the mesh conveyor is successfully preventing cross contamination in the post-optical streams, which would result in more residue and higher operating costs. The presence of film across the optical sensing area causes recovery and quality issues with the optically sorted material, and in particular with PET.

The conveyor extracts lightweight materials such as loose film and contaminates such as small amounts of other light flat materials such as trays. At one time this material was considered part of the residue stream however, over the past year this material has been placed in with mixed plastics and sold to market. The design also includes a QC sorting station after the mesh conveyor for the film but Niagara has never found it necessary to place staff in this area. A number of the suction fans and motors have required replacement over time, but overall the mesh conveyor has been a reliable and cost effective way to remove film and other light contaminants.

5. Project Budget

5.1 Project Budget

The project budget as described in the CIF agreement appears below, with a total project value for purchase and installation of $2,061,412.

	Item	Amount	Scheduled Payment
1	Deposit with Order	$206,141	May 2009
2	15% deposit upon approval of general arrangement, equipment drawings with specs	$309,212	October 2009
3	15% upon 50% manufacturing completion	$309,212	December 2009
4	30% upon delivery of all equipment	618,424	Q1 2010
5	20% upon completion of installation	$412,282	Q1 2010
6	10% upon successful acceptance testing	$206,141	Q1/2 2010
	Total	$2,061,412	

6. Conclusions

The installation of optical sorting technology is considered to be a success for Niagara Region, and has helped the Region to achieve higher recovery and obtain better revenues for PET and mixed plastics. Those contemplating the installation of optical sorting can learn from the Niagara experience in a number of ways:

- The technology will be useful in capturing and streaming targeted plastics, and further in maximizing revenues for these products. In the case of Niagara, PET and high-grade mixed plastics were successfully targeted by the system;

- Process flows are important. Prior to releasing an RFP or specifications, review the MRF process flows and the proposed location for the system to determine whether other systems – the eddy current, in the case of Niagara – should be moved ahead of the optical sorting process;

- Labour savings may not be realistic to expect as there is a need for a QC function following the optical sorter. Some materials may be ejected with the target material, and requires removal, while other materials may be missed (PET with liquid inside). In the case of Niagara the system impact on labour was neutral, requiring a reallocation of people, not a reduction; and

- Programs considering installing optical sorting should collect baseline data using residue audits and marketing information including tonnes sold and material sales.

In general, for a program the size of Niagara Region and based the high quantity of plastic packaging processed by the system, the addition of optical sorting technology was required and necessary to keep up with the processing needs of the community.

APPENDIX A

Pellenc Sorter Specifications

I. CONTAINERS OPTICAL SORTING UNIT

(OPT-114)

Pellenc ST model MISTRAL PLASTIC 20-05T METAL

Composed of :

- 1 halogen lighting system, protected by a glass pane
- 1 NIR (Near Infra-Red) scanning acquisition system, 2000 mm working width
- 1 input optical fibre bundles
- 1 air-conditioned electric control cabinet, including:
  - high speed infra-red spectrometer
  - central computing unit
  - associated software
  - touch screen control panel with user-friendly menus
  - safety and protection components
  - modem access for remote maintenance
- 2 compressed air nozzle ejection units
- 1 metal detector 2000 mm working width
- buffer air tank

  **All of the above devices are integrated into a welded frame encased in polycarbonate covers comprising 2 side access doors with safety switch

- 1 output box with 2 side access doors
- 1 year coverage of remote maintenance including access to :
  - On-line diagnostic in case of failure
  - Perform remote corrective actions
  - Ensure technical support on line
- The delivery will include a technical documentation in English language for each machine comprising:
  - The general plans
  - The operation and maintenance manual: 1 set + 1 CD per machine
  - The list of spare and wear parts.

TECHNOLOGY SCOPE

Material detection per Near Infra-Red Measuring System (NIR) :

The original conception of our sensor and lighting system brings key advantages:

- Very high speed
- **300.000 measures per second**
- Also the quality of the signal is far superior to the classic technologies (ratio signal/noise: 20 times superior)
- The analysis resolution is **1 cm^2**
- The analysis is concentrated on the zones of the spectrum allowing the best recognition of the materials
- High precision of the synchronisation system of detection/ejection, at the millisecond

The distance between the detection line and the ejection line is only **15 cm.** This allows **a <u>better efficiency</u>** of ejection of the rolling objects which can move on the belt before the ejection line, major cause of 'lost' material.

METAL DETECTOR

Device allowing ejection of metallic particles coupled to the ejection units with high-precision synchronisation between detection and ejection.

1- Classes of identified materials:

- Ferrous metals including stainless steel
- Non-ferrous including aluminium
- Aluminium foils
- Small metallic objects

2- Product type: Tins, Sprays, Cans, Tetra or soft packaging, Aluminium cartons, tops

3- Guaranteed detection range:
Maximum distance from the conveyor belt allowing the detection of metallic particles: entire hollow bodies, even crushed: up to 120 mm over the conveyor belt

4- Variable sensitivity:
Ejection of the metallic particles is adjustable in function of the stream composition and the quality target.

APPENDIX B

Residue Audits

Appendix 1 - Optical Sort Audit Summary

Optical Sorter Pre-Installation

Date	Plastic #1	%	Plastic #3	%	Plastic #4	%	Plastic #5	%	Plastic #6	%	Aluminum	%	Steel	%	Paper	%	Cardboard	%	Boxboard	%	Polycoat	%	Prohibitives	%	Total Weight (lbs)
19-Jul-07	161.5	51.2%	53.5	17.0%	7	2.2%	29	9.2%	11.5	3.6%	14	4.4%	0.5	0.2%	8.5	2.7%	14	4.4%	7.5	2.4%	N/A	-	8.5	2.7%	315.5
27-Jul-07	146.5	48.3%	2	0.7%	6	2.0%	22	7.2%	30.5	10.0%	20	6.6%	1	0.3%	18.5	6.1%	2.5	0.8%	2	0.7%	21.5	7.1%	31	10.2%	303.5
Averages	154	49.7%	27.75	8.8%	6.5	2.1%	25.5	8.2%	21	6.8%	17	5.5%	0.75	0.2%	13.5	4.4%	8.25	2.6%	4.75	1.5%	21.5	7.1%	19.75	6.5%	309.5

234.75 75.8%

On average, 82.8% of the residue stream in 2007 was comprised of recyclable plastics.

Optical Sorter Post-Installation Q1 Summary

Date	Plastic #1	%	Plastic #3	%	Plastic #4	%	Plastic #5	%	Plastic #6	%	Aluminum	%	Steel	%	Paper	%	Cardboard	%	Boxboard	%	Polycoat	%	Prohibitives	%
Q1 Audits Dates																								
18-Oct-11	12.0	4.6%	0.5	0.2%	1.0	0.4%	4.5	1.7%	3.5	1.3%	11.0	4.2%	16.0	6.1%	16.0	6.1%	4.0	1.5%	13.5	5.2%	17.5	6.7%	61.0	23.3%
21-Nov-11	15.0	6.1%	2.0	0.8%	1.5	0.6%	5.0	2.0%	4.0	1.6%	13.0	5.3%	11.5	4.7%	18.5	7.5%	10.5	4.3%	20.5	8.3%	60.0	24.4%	50.5	20.5%
12-Dec-11	23.5	7.8%	0.5	0.2%	1.0	0.3%	6.0	2.0%	8.0	2.7%	10.0	3.3%	8.5	2.8%	42.5	14.2%	31.0	10.3%	31.0	10.3%	13.5	4.5%	51.5	17.2%
Q1 Averages	16.8	6.2%	1.0	0.4%	1.2	0.4%	5.2	1.9%	5.2	1.9%	11.3	4.3%	12.0	4.5%	25.7	9.3%	15.2	5.4%	21.7	7.9%	30.3	11.9%	54.3	20.3%

53.17 19.8%

On average, 19.8% of the residue stream in October, November and December of 2011 was comprised of recyclable plastics.

Optical Sorter Post-Installation Q2 Summary

Date	Plastic #1	%	Plastic #3	%	Plastic #4	%	Plastic #5	%	Plastic #6	%	Aluminum	%	Steel	%	Paper	%	Cardboard	%	Boxboard	%	Polycoat	%	Prohibitives	%
Q2 Audits Dates																								
16-Jan-12	37.5	14.3%	0.5	0.2%	1.5	0.6%	8.0	3.1%	8.5	3.3%	15.5	5.9%	12.5	4.8%	32.0	12.2%	7.0	2.7%	21.5	8.2%	46.0	17.6%	47.0	18.0%
15-Feb-12	23.0	9.3%	1.0	0.4%	2.0	0.8%	6.5	2.6%	4.0	1.6%	19.5	7.9%	12.5	5.1%	17.0	6.9%	8.0	3.3%	14.0	5.7%	39.5	16.1%	49.0	19.9%
12-Mar-12	20.5	6.8%	0.5	0.2%	2.0	0.7%	7.5	2.5%	10.5	3.5%	14.0	4.7%	15.0	5.0%	15.0	5.0%	4.5	1.5%	26.5	8.8%	41.5	13.8%	100.0	33.3%
Q2 Averages	27.0	10.2%	0.7	0.3%	1.8	0.7%	7.3	2.7%	7.7	2.8%	16.3	6.2%	13.3	5.0%	21.3	8.0%	6.5	2.5%	20.7	7.6%	42.3	15.8%	65.3	23.7%

66.00 19.5%

On average, 19.5% of the residue stream in January, February and March of 2012 was comprised of recyclable plastics .

Optical Sorter Post-Installation Q3 Summary

Date	Plastic #1	%	Plastic #3	%	Plastic #4	%	Plastic #5	%	Plastic #6	%	Aluminum	%	Steel	%	Paper	%	Cardboard	%	Boxboard	%	Polycoat	%	Prohibitives	%
Q3 Audits Dates																								
10-Apr-12	39.5	15.1%	1.0	0.4%	1.5	0.6%	8.5	3.3%	4.0	1.5%	16.5	6.3%	10.0	3.8%	16.0	6.1%	4.5	1.7%	13.0	5.0%	34.0	13.0%	41.0	15.7%
16-May-12	26.0	10.6%	0.5	0.2%	0.5	0.2%	5.0	2.0%	5.0	2.0%	8.5	3.5%	7.5	3.0%	7.5	3.0%	8.0	3.3%	11.5	4.7%	24.0	9.8%	43.0	17.5%
12-Jun-12	25.0	8.3%	1.0	0.3%	1.0	0.3%	8.0	2.7%	3.0	1.0%	12.0	4.0%	7.0	2.3%	14.0	4.7%	2.0	0.7%	9.0	3.0%	21.5	7.2%	71.0	23.7%
Q3 Averages	30.2	11.3%	0.8	0.3%	1.0	0.4%	7.2	2.6%	4.0	1.5%	12.3	4.6%	8.2	3.1%	12.5	4.6%	4.8	1.9%	11.2	4.2%	26.5	10.0%	51.7	18.9%

69.33 28.7%

On average, 28.7% of the residue stream in April, May and June of 2012 was comprised of recyclable plastics.

Optical Sorter Post-Installation Q4 Summary

Date	Plastic #1	%	Plastic #3	%	Plastic #4	%	Plastic #5	%	Plastic #6	%	Aluminum	%	Steel	%	Paper	%	Cardboard	%	Boxboard	%	Polycoat	%	Prohibitives	%
Q4 Audits Dates																								
17-Jul-12	35.0	13.4%	0.5	0.2%	0.5	0.2%	9.0	3.4%	5.0	1.9%	13.5	5.2%	4.0	1.5%	13.5	5.2%	1.0	0.4%	9.0	3.4%	22.5	8.6%	44.0	16.8%
29-Aug-12	54.5	22.2%	1.5	0.6%	1.0	0.4%	5.0	2.0%	4.0	1.6%	26.0	10.6%	9.0	3.7%	27.0	11.0%	10.0	4.1%	13.0	5.3%	17.5	7.1%	45.5	18.5%
19-Sep-12	54.0	18.0%	2.5	0.8%	1.5	0.5%	10.0	3.3%	4.5	1.5%	15.5	5.2%	5.0	1.7%	16.0	5.3%	5.0	1.7%	10.5	3.5%	15.0	5.0%	43.0	14.3%
Q4 Averages	47.8	17.8%	1.5	0.5%	1.0	0.4%	8.0	2.9%	4.5	1.7%	18.3	7.0%	6.0	2.3%	18.8	7.2%	5.3	2.0%	10.8	4.1%	18.3	6.9%	44.2	16.6%

85.33 36.4%

On average, 36.4% of the residue stream in July, August and September of 2012 was comprised of recyclable plastics.

Optical Sorter Post-Installation New Categories

Date	Plastic #2	%	Plastic #7	%	Unknown Plastic	%	Plastic Bags	%	Glass	%	Paper Coffee Cups	%	Coffee Cup Lids	%	Total Weight (lbs)
Q1 Audits Dates															
18-Oct-11	9.0	3.4%	0.5	0.2%	17.0	6.5%	3.5	1.3%	64.0	24.5%	5.5	2.1%	1.5	0.6%	261.5
21-Nov-11	5.0	2.0%	1.5	0.6%	6.5	2.6%	8.0	3.3%	5.5	2.2%	6.0	2.4%	1.5	0.6%	246.0
12-Dec-11	8.5	2.8%	1.0	0.3%	18.0	6.0%	13.5	4.5%	19.5	6.5%	6.0	2.0%	1.5	0.5%	300.0
Q1 Averages	7.5	2.8%	1.0	0.4%	13.8	5.0%	8.3	3.0%	29.7	11.1%	5.8	2.2%	1.5	0.6%	269.2

Optical Sorter Post-Installation New Categories

Date	Plastic #2	%	Plastic #7	%	Unknown Plastic	%	Plastic Bags	%	Glass	%	Paper Coffee Cups	%	Coffee Cup Lids	%	Total Weight (lbs)
Q2 Audits Dates															
16-Jan-12	7.5	2.9%	1.5	0.6%	14.0	5.4%	19.0	7.3%	25.0	9.6%	5.5	2.1%	1.0	0.4%	311.0
15-Feb-12	6.0	2.4%	2.0	0.8%	8.0	3.3%	8.5	3.5%	72.5	29.5%	6.0	2.4%	1.0	0.4%	300.0
12-Mar-12	10.5	3.5%	1.5	0.5%	10.0	3.3%	10.0	3.3%	106.5	35.5%	9.5	3.2%	1.5	0.6%	402.0
Q2 Averages	8.0	2.9%	1.7	0.6%	10.7	4.0%	12.5	4.7%	68.0	24.8%	7.0	2.6%	1.2	0.5%	337.7

Optical Sorter Post-Installation New Categories

Date	Plastic #2	%	Plastic #7	%	Unknown Plastic	%	Plastic Bags	%	Glass	%	Paper Coffee Cups	%	Coffee Cup Lids	%	Total Weight (lbs)
Q3 Audits Dates															
10-Apr-12	8.0	3.1%	1.5	0.6%	15.5	5.9%	10.0	3.8%	64.5	24.7%	4.0	1.5%	1.0	0.4%	294.0
16-May-12	6.5	2.6%	0.5	0.2%	12.5	5.1%	12.0	4.9%	16.5	6.7%	3.0	1.2%	1.0	0.4%	198.5
12-Jun-12	7.0	2.3%	2.0	0.7%	22.0	7.3%	11.0	3.7%	11.0	3.7%	4.0	1.3%	1.0	0.4%	232.5
Q3 Averages	7.2	2.7%	1.3	0.5%	16.7	6.1%	11.0	4.1%	30.7	11.7%	3.7	1.4%	1.0	0.4%	241.7

Optical Sorter Post-Installation New Categories

Date	Plastic #2	%	Plastic #7	%	Unknown Plastic	%	Plastic Bags	%	Glass	%	Paper Coffee Cups	%	Coffee Cup Lids	%	Total Weight (lbs)
Q4 Audits Dates															
17-Jul-12	8.5	3.3%	0.5	0.2%	7.5	2.9%	9.5	3.6%	18.0	6.9%	0.5	0.2%	0.5	0.2%	202.5
29-Aug-12	10.5	4.3%	1.5	0.6%	10.0	4.1%	10.0	4.1%	13.5	5.5%	5.0	2.0%	2.0	0.8%	266.5
19-Sep-12	12.0	4.0%	2.0	0.7%	11.0	3.7%	9.0	3.0%	16.0	5.3%	5.5	1.8%	1.5	0.6%	234.5
Q4 Averages	10.3	3.8%	1.3	0.5%	9.5	3.5%	9.5	3.6%	15.8	5.9%	366.7%	1.4%	1.3	0.5%	234.5

APPENDIX C

Audit Procedure

Niagara Region – Waste Management Services	Effective Date: February 2, 2012
Post Installation Optical Sort Audit Procedure	Number: # 2012-005
Revised by: NA	Revision date: NA
Approved by: Lucy McGovern	Approved date: February 2, 2012

1. Rationale/Background:

The post-installation optical sort audits are completed to help rate the performance of the new dual eject optical sorting system that was installed in the spring of 2010. In order to evaluate the effectiveness of the optical sorting system, current performance will be compared to system performance prior to the installation of the optical sorting system when all container types were manually sorted. The installation of the dual eject optical sorting system has increased the recovery of PET and mixed plastics in Niagara Region and reduced labour costs associated with plastic sorting. The optical sorting system provides three streams of material as follows:

1. PET bottles, jars, trays and clamshells are upward ejected
2. Mixed plastics (HDPE, PVC, PP, PS etc,) are downwards ejected
3. Polycoat containers and aluminum pass through

Niagara Region will complete one audit each month between October 2011 and September 2012.

2. Purpose:

The purpose of this procedure is to provide the information required for Waste Management Interns (WMIs) to conduct the optical sorter post installation audits and to document the audit results.

3. When to use this Procedure:

This procedure is to be used when conducting an optical sort audit. The WMIs shall complete one optical sort audit each month between October, 2011 and September, 2012.

4. Roles and Responsibilities:

The Waste Management Interns are responsible for the implementation and maintenance of this procedure.

5. Tools:

The tools required to conduct the audits are:

- Audit Form
- Pen
- Label Tags (optional)
- Clipboard

- Broom
- Protective Clothing including: safety glasses, safety boots, vests, gloves and face mask (optional)
- Totes/Bins
- Scale
- Link to audit information L:\2007 Beyond\E09 Waste Diversion\Recycling Centre\Audits

6. Procedure:

a) Audit Preparation

- The Waste Management Intern primarily responsible for audits shall schedule the audits in the Intern Schedule based on the availability of the other interns. The Intern Schedule can be found at the following file path:
  L:\2007 Beyond\zStudents\1Student Schedule

- Each Friday, the Waste Management Intern primarily responsible for audits shall post a schedule of the required audits that must be completed the following week on the Niagara Recycling Controller's office door. This list will let Niagara Recycling staff know the type of audit required and the date and approximate time the audit samples must be ready by. Once the audit sample has been collected and dumped onto the audit table, Niagara Recycling staff will complete the form with the audit weight, the line speed and the number of sorters. A blank copy of the 'Weekly Audit Schedule' can be found at the following file path:
  L:\2007 Beyond\E09 Waste Diversion\Recycling Centre\Audits\2011\Weekly Audit Schedule

- The Waste Management Intern primarily responsible for audits shall schedule the audits in the Intern Schedule based on the availability of the other interns. The Intern Schedule can be found at the following file path:
  L:\2007 Beyond\zStudents\1Student Schedule

- All WMIs shall review the optical sort audit categories before conducting an optical sort audit. This will ensure that the audit is being sorted correctly and consistent for the all post installation optical sorter audits. The sorting categories for the optical sort audits can be found below in the 'Conducting the Audit' section.

- On the day of the requested audit, the WMIs shall check the audit table (located in Bay 1) to make sure the audit sample has been dumped. If the audit sample has not been dumped, the Intern shall follow up with the Niagara Recycling General Manager or Controller to prepare the audit sample. It takes approximately 15 minutes for the sample to be collected and dumped onto the audit table.

- Samples will be collected from the end of the container line by Niagara Recycling staff and will be between 200 and 300 lbs each. The collection sample will be segregated and manually sorted into material categories by the WMIs. Designation of material categories are based on Blue Box material types accepted for recycling in the Region's recycling program. Each category will be weighed, the percent composition determined and the results will be compared to similar audit results compiled in July of 2007 prior to the installation of the optical sorting system.

- The WMIs shall obtain a blank optical sorter post-installation form and bring it to Bay 1 to document the audit results. Blank forms can be obtained from the WMI primarily responsible for the optical sort audits or on the L drive at the following file path: L:\2007 Beyond\E09 Waste Diversion\Recycling Centre\Audits\2011\Optical Sort Post Installation Audits\BLANK Optical Sort Audit Sheet

- WMIs shall wear the personal protective equipment listed in section 5, 'Tools', prior to entering the Bay 1 audit area of the Recycling Centre.

b) Conducting the Audit

- Once in the Bay 1 audit area, WMIs shall collecting empty bins to separate the audit material. When conducting an optical sorter post installation audit approximately 20 containers (totes or boxes) are needed. Ensure that all the containers are empty and weigh each container separately on the scale located on the north wall of the audit area. WMIs shall record the tare weight of each box or tote on the Optical Sort Audit Sheet. Many of the containers are already identified with their tare weights on the top corner of each container. If there are not enough containers to conduct the audit, speak to the Niagara Recycling Controller or the Leadhand for assistance. **To ensure safety, WMIs are not permitted to travel beyond Bay 1**. WMIs shall separate the audit material into the bins using the following categories:

  Optical Sorter Post Installation Audit Categories

  - Plastic #1 Container
  - Plastic #1 Bottle
  - Plastic #2
  - Plastic #3
  - Plastic #4
  - Plastic #5
  - Plastic #6
  - Plastic #7
  - Unknown Plastic
  - Aluminum
  - Steel/Spiral Containers
  - Plastic Bags

- Polycoat
- Garbage
- Paper
- Cardboard
- Boxboard
- Glass
- Paper Coffee Cups
- Coffee Cup Lids

Waste Management Interns shall:

- Place the weighed empty containers beside the audit sample.
- Begin to sort the sample by placing each type of material into appropriate container. *Note: Sometimes the containers will become full before the sorting of the sample is complete. If this happens weigh and record the weight of the full container and dump it into a container that is not being used. Continue with the now empty container.*
- Sort as much of the sample as possible including small scraps and small pieces of paper. The entire sample shall be sorted into proper categories, within reason. The original audit sample weight shall be as close as possible to the combined weight of all the separated audit categories.
- Count all the paper coffee cups and coffee cup lids. Record the number of each.
- Ensure that all material that has fallen onto the floor during the audit is picked up and sorted to ensure that as much of the sample is being sorted as possible.
- Make a note on the Optical Sort Audit Sheet of any material that could not be sorted. i.e.: small pieces of glass, garbage or fine pieces of paper.
- Take a picture of all the different categories once the audit is complete. It is wise to write down the order that the pictures were taken in as this will make it easier to identify the photos when they are uploaded and labeled. Bring all the bins to the scale and weigh each container separately. Tare weights and final weights shall be documented on the audit form.
  Note: If more than one container exists per category, each weight shall be documented separately and then added together.
- Consolidate all the material into totes and line up the totes to the side of the scale in Bay 1, with lids open. This will indicate to Niagara Recycling staff that the audit is complete and the totes may be emptied.
  Note: Do not block the path to the fire hose located beside the scale with totes.
- Clean the audit table of any leftover material from the audit. The leftover material can be placed in a tote and lined up with the other totes to be emptied.

- Sweep the floor around the audit table after each audit to ensure that material from one audit does not get mixed with a new sample.
  Note: Depending on the number of available interns and the size of the audit, it takes approximately 5 interns and 5 hours to complete one optical sort audit.

c) Recording Audit Results

The WMI primarily responsible for audits shall:

- Input the audit results on the Optical Sort Audit Form into the excel spreadsheets found at the following file path:
  L:\2007 Beyond\E09 Waste Diversion\Recycling Centre\Audit\2011\Optical Sort Post Installation Audits\Optical Sorter Pre and Post Installation Audit Summary
- Create a new tab after the previous audit, and rename it with the audit date. The previous tab will have Excel formulas in the boxes which makes it easier than starting from a blank form. Copy and paste the last audit results into the new tab, space everything accordingly and input the new data.
- Fill out the top portion of the form, condition of material, line speed, number of sorters, sample weight, and weight sorted. Calculate the weights for each category by subtracting the final weight from the starting weight. The percentages will change in the spreadsheet as the new numbers are inputted.
- Make sure the total percentage adds to a total of 100%. (If not, the WMI shall recheck their work).
- Develop a pie chart to show the results from the current audit.
- Upload the pictures and name them according to the category. A new file shall be created and named according to the date the audit was dumped and put in the following folder:
  L:\2007 Beyond\E09 Waste Diversion\Recycling Centre\Audit\2011\Optical Sort Post Installation Audits\Monthly Audit Pictures
- Save the work
- Send the file to the Waste Management Program Manager and the Controller for Niagara Recycling.

8. Contacts:

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