CIF Final Report #957

Durham Region MRF Container Line Productivity and Efficiency Upgrade

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Prepared for:
Resource Productivity and Recovery Authority
Continuous Improvement Fund

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Executive Summary

This report outlines the results of the container line processing equipment upgrade at the Region of Durham's Material Recovery Facility (MRF). This initiative was funded in part through a grant from the Continuous Improvement Fund (CIF).

Durham Region's Blue Box material composition has shifted to where fibre materials now account for 67% of materials by weight and containers account for 33% by weight. The split was closer to 80% fibres and 20% containers when the Durham MRF was first built over twelve years ago. Container density also dropped, and associated volumes have significantly increased. These changes have resulted in significant performance challenges for the Durham MRF and the operating contractor.

The purpose of this project was to increase the Durham MRF's container processing capacity while reducing burden on conveyers and increasing material capture. This was accomplished by updating processing equipment to improve glass processing and optical sorting of PET and mixed plastics, and to alleviate increasing cost pressures arising from the MRF's increasing inability to effectively process today's blue box materials.

The Region removed an air separator cyclone which separated heavy containers from lighter containers and an old glass screen replacing them with a new glass breaker and heavy-duty perforator. A new high-volume wide PET optical sorter was also installed. Further amendments were made to associated infrastructure including compressors, conveyors, storage bunkers, blowers, quality control stations, electrical, and sprinkler systems.

This project successfully increased the capture of PET recyclables by 4%, mixed plastics by 1%, mixed broken glass by 5.8%, and realized avoided costs of an estimated $729,424 per year based on not running a second containers line shift after the upgrades which processing contractor was looking for reimbursement. Results were achieved by:

- increasing revenue from tonnes marketed (lower overall inbound tonnage but 6% increase in marketed containers),
- improving container line productivity (58% throughput increase and 28.6% reduction in downtime), and
- decreasing container line operating time by 43% (15 hours down to 8.5 hours).

The overall return on investment for this project was 2.2 years.

1. Introduction

Durham Region is a 2-tier municipality made up of 8 lower-tier municipalities. It is the largest geographical jurisdiction in the Greater Toronto Area stretching from Lake Simcoe in the north to Lake Ontario in the south, and from as far west as Pickering to Newtonville in the east. The Region encompasses an area of approximately 2,532 square kilometers and is home to approximately 673,500 residents.

Durham Region has operated a Blue Box program for over 25 years, currently servicing approximately 212,000 residential curbside recycling stops, 25,064 multi-residential units in 398 buildings, and three Waste Management Facilities (WMF) that accept residential recyclables.

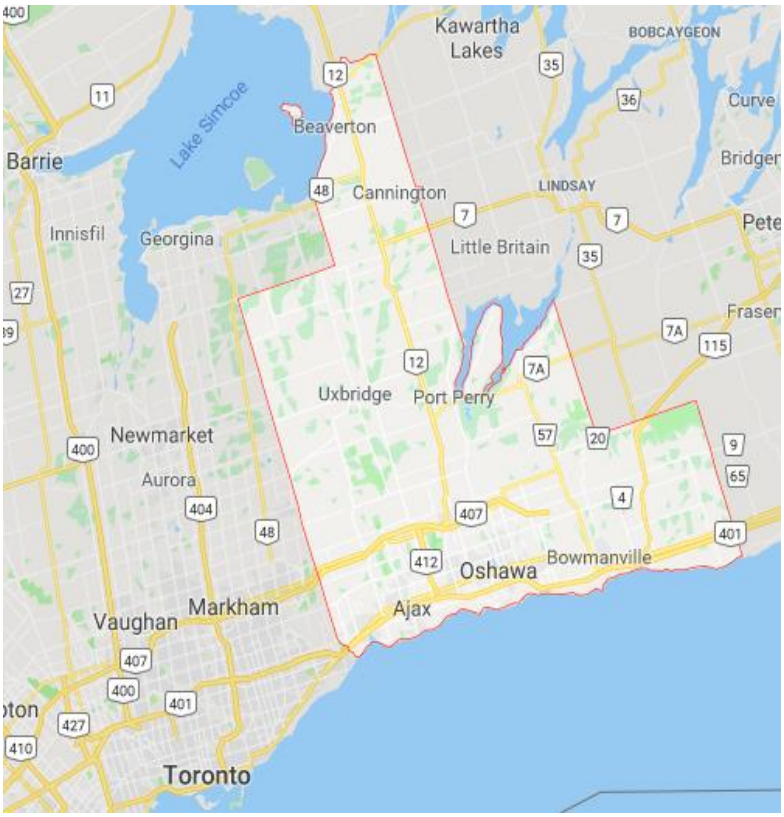


Figure 1: Map of Durham Region, Ontario, Canada

Roughly 50,000 MT of Blue Box materials are collected for processing annually with a residue rate of approximately 8% in 2018. The Region owns the Material Recovery Facility (MRF) and contracts out its operation and maintenance to Miller Waste Systems Inc. This contract was awarded in 2012 and the Region recently enacted the option to extend three additional years, until November 2022. The Region is responsible for maintaining the building envelope, undertaking major capital projects including equipment replacement and upgrades, and major reports.

Durham's MRF is a dual stream operation in which paper fibres and containers are collected and processed separately from each other. It opened in 2007.

In 2016, Regional staff observed the following issues:

- Decreasing glass quality resulting in increasing frequency of glass load rejections and backhaul expenses;
- Increasing difficulty for infeed conveyers to manage depth burden resulting in throughput decreases (especially during winter months when containers were wet and heavy);
- Increasing cross contamination at Pellenc optical sorters from line depth burden (both units had already been converted from dual ejecting to single ejecting);
- Increased "targeted" plastics being found in outbound residue stream which resulted in higher residue disposal costs and loss of marketable material revenue;
- Increasing amounts of glass throughout sorting process resulting in increased wear on equipment and conveyors and increasing maintenance costs;
- Increasing pressure from Contractor for Region to cover costs of a second shift that was required to make up for the MRF's decreasing process efficiencies arising from volume increases and composition changes.

It was noted that the likely reason for the MRF's increasing inefficiencies was that it was designed to process a suite of materials that were significantly heavier on the fibre stream and which did not include PET #1 thermoform, mixed #3-#7 plastics, large jugs and pails, or many of the new lighter weight and single serve "convenience" packaging materials that are now part of the Ontario curbside blue box mix.

The Region was granted partial funding from the Continuous Improvement Fund (CIF) for the MRF container line productivity and efficiency upgrades outlined in this report. A major predictor for success of the upgrades would be the elimination of the need for the second shift to process containers. Durham's operating and maintenance contract was set to end in 2017 and Durham anticipated substantial processing cost increases if a new contract was left to start without any process equipment upgrades.

This report presents a brief review of Durham MRF equipment upgrades and provides the data to quantify the outcomes.

2. Background

Durham Region owns the Material Recovery Facility (MRF) located at 4590 Garrard Road, Whitby, ON. In Durham, recyclables are collected through the residential curbside collection program serving single family households and the cart collection program servicing multi-residential dwellings. The recyclable material is collected and processed in two streams:

1) Fibre Products: Boxboard (OBB), corrugated cardboard (OCC), newsprint (ONP); and
2) Containers: steel and aluminum containers/trays, plastics #1-7 (black plastic accepted but not plant pots and trays), glass (clear, coloured and mixed coloured), juice boxes and milk cartons.

The Region does not accept film plastic, coffee cups, or any polystyrene in its curbside system. Expanded polystyrene is collected at Regional WMFs locations.

The increasing volume of plastics has been challenging the existing MRF container processing design since the 2013 addition of #3-7 plastics in the blue box and the overall market shift toward lighter weight products and packaging. Recently, these have required the MRF contractor to add a second shift on the container line and absorb the associated cost. This second shift was not anticipated at the beginning of the contract. However, the second shift was required for the contractor to meet its performance requirements and has been putting pressure on the Region for the Region to absorb its additional costs.

The MRF is currently not licensed to accept materials from beyond the Region. If Durham wishes to optimize any surplus capacity by accepting materials from jurisdictions outside the Region, then it must seek ECA approval to do so. Internal authority and mechanisms exist to facilitate this ECA approval. They include:

- Council authority to investigate opportunities to maximize use of existing infrastructure and programs (Report No. 2009-J-1, part 8, page 4 – Appendix A - Optimization of Regional Solid Waste ManagementAppendix A) on a full cost recovery basis, and;
- The current processing contract (extended from November 2019 until November 2022) allows the Durham MRF to receive 3rd party materials (RFP 168-2012, Section 5.19 - see Appendix B).

Since 2012 staff has noted a shift in the composition of incoming Blue Box. Particularly, in 2012, Fibre materials made up approximately 72% of the material stream while containers made up the remaining 28%. By 2015, composition had shifted to 68% Fibres and 32% Containers (See Table 1).

Table 1: Blue Box Materials Composition Change 2012-2015

Durham MRF Commodity Stream Percentages 2012-2015

Stream	2012	2013	2014	2015
Newspaper	53.6%	54.5%	52.6%	51.8%
Mixed Paper	7.1%	4.9%	4.2%	4.0%
Cardboard	10.8%	12.0%	13.3%	12.6%
Fibre Composition	**71.6%**	**71.4%**	**70.2%**	**68.4%**
Aluminum	1.5%	1.4%	1.2%	1.3%
Steel	3.5%	3.6%	3.5%	3.4%
PET Plastic	4.5%	5.3%	5.6%	6.3%
HDPE Plastic	1.7%	1.4%	1.3%	1.5%
Mixed Plastic	1.0%	3.1%	3.3%	1.5%
Gabletop/Polycoat	1.0%	1.1%	1.0%	1.0%
Glass	9.7%	10.1%	10.7%	11.7%
Residue	5.5%	2.7%	3.5%	4.9%
Container Composition	**28.4%**	**28.6%**	**29.8%**	**31.6%**

The 3% shift in the blue box composition from paper fibres to containers outlined in Table 1 represented a significant increase in containers the MRF processed because, while the container tonnage increased relative to paper fibres, light-weighting of containers was also happening through a shift from glass to plastic containers and a thin-walling of plastic containers between 2012-2015. New types of plastic containers also appeared on the market and they were getting larger and larger.

This increase was most visible in the lighter plastics streams of PET and Mixed Plastics. PET within the container stream had increased by approximately 39.2% and Mixed Plastics had increased by 58.1% during that four years (See Table 2). This had the effect of an exponential increase in the number of containers being processed and an associated decrease in processing efficiency with increased in processing costs causing the Region to experience an increase of approximately 29.1% (between 2012 and 2015) in the amount of all plastic containers tonnes processed at the MRF (See Table 2Table 1: Blue Box Materials Composition Change).

Table 2: Container Line Tonnes Processed 2012-2015

Durham MRF Container Line Tonnes Processed 2012 - 2015

Year	Commodity								Total Containers Processed	Total Plastics Processed	% Plastics
	Glass	Aluminum	Steel	PETE	HDPE	Mixed Plastics	Polycoat	Residue*			
2012	4,583.4	690.5	1,668.1	2,135.6	809.8	454.9	449.4	2,579.3	10,791.8	3,400.3	31.5%
2013	4,746.1	670.2	1,699.3	2,500.8	657.2	1,458.7	503.2	1,276.0	12,235.5	4,616.8	37.7%
2014	5,120.6	577.3	1,665.4	2,674.9	605.6	1,562.5	459.5	1,670.8	12,665.6	4,842.9	38.2%
2015	5,539.8	610.5	1,610.9	2,971.9	697.1	719.3	466.9	2,322.7	12,616.4	4,388.3	34.8%
% change	20.9%	-11.6%	-3.4%	39.2%	-13.9%	58.1%	3.9%	-9.9%	16.9%	29.1%	

* Residue is from the entire plant (including fibre residue) and is not included under 'Total Containers Processed'

All of Durham's MRF sort lines are based on moving products and packaging by their volumes, not their weight. However, equipment throughput efficiency is measured by weight moved per hour. Therefore, the increased volume of plastics resulted in the lowering of the processing throughput weights, and resulting efficiency, on the container line. The volume and mix of material collected from households in the Region, as was the case with the rest of Ontario, changed more rapidly than expected and resulted in the Region's MRF processing system not being well matched with the material it was processing. This increase forced the Region's processing contractor to add a second shift on the containers line to deal with extra volume and to meet its processing efficiency requirements.

Since 2012, the Region has completed several capital upgrades to the MRF in order to accommodate these new plastic materials and to keep up with the changing container stream composition. The upgrades include:

- A software upgrade and reprogramming of the two dual-eject optical sorters;
- Modification of the existing air compressor;
- Installation of a second air compressor;
- Upgrades to motors, gear boxes, variable frequency drives;
- Additional/Increased heights of cleats on conveyor belts;
- Oversized HDPE chute in pre-sort and;
- Installation of a new baler

In addition, the Region also installed a residual-clean up system (RCUS) located adjacent to the residue compactor in order to perform a final quality control check of all residual material prior

to disposal. The material captured on this line is either sorted into specific material grades to be baled or sent to be reprocessed. These improvements enabled the Region to keep up with the changing material composition and to reduce the amount of residue by almost 50%. However, by 2016, the Region noted that the MRF's efficiency was declining and its residue tonnage/percentage started to increase again to 2012 levels or pre RCUS.

2.1 Overview of the Container Line at the Durham MRF

On average, the Durham MRF was processing six tonnes of containers per hour before the MRF equipment upgrades outlined in this report. Since the addition of plastics #3-#7, the amount of material being processed on the container line increased by 3%.

The original line had a pre-sort room (to remove large visible residue), a magnet to capture ferrous metals, a glass screen, an air separator heavy-light cyclone, and a plastics perforator. This was followed by two dual ejecting Pellenc optical sorters. The first optical positively sorted PET and negatively sorted Tubs & Lids. The second optical positively sorted Gable & Aseptic containers and negatively sorted HDPE. Materials then moved to a main containers sort room which focused on removing mixed plastics and Aseptic containers and Cartons. The final mechanical sort involved an eddy current separator to capture aluminum. The MRF's single baler is dedicated to baling sorted containers. OCC, mixed paper, ONP and glass is shipped to market loose. A residual-clean up system was implemented in 2012 to perform a final removal of divertible materials prior to sending the residual stream to disposal.

2.2 Project Goals and Objectives

The Region proposed a redesign of the container line that included a $1.46 M investment in new equipment to accommodate the shift in packaging. The redesign included the following changes:

- Replace the existing air separator cyclone (heavy-light system) and old glass screen with a new glass breaker screen;
- Add new plastic perforator (4 shaft, dual stage perforator which can handle the throughput/volume of plastic and any over-sized plastics if missed by pre-sort);
- New PET optical sorter (high volume/wide), new optics speed belt and new PET quality control sort line to remove any contaminants from the optically ejected PET back to the main sort line; and
- New air blower to blow the sorted PET to an oversize storage bunker.

Building modifications/expansions and other associated installation costs approximately $303,000 and included:

- An improved compressor room and expanded optical sort room;
- Various new/modified container transfer conveyors; and,

- Associated sprinkler and electrical modifications.

The Region expected the redesign/upgrade features to eliminate the need for the second shift on the container line and its associated costs. Specific anticipated cost reductions included:

- Labour costs due to lowered manual sorting requirements;
- Glass stream processing expenses due to improved equipment efficiencies;
- Unscheduled downtime costs due to equipment maintenance and processing backlogs, and;
- Residual waste disposal costs due to reduced residual waste tonnage.

The Region also anticipated an improvement in revenues from the higher quantity and quality plastics output of the equipment upgrades.

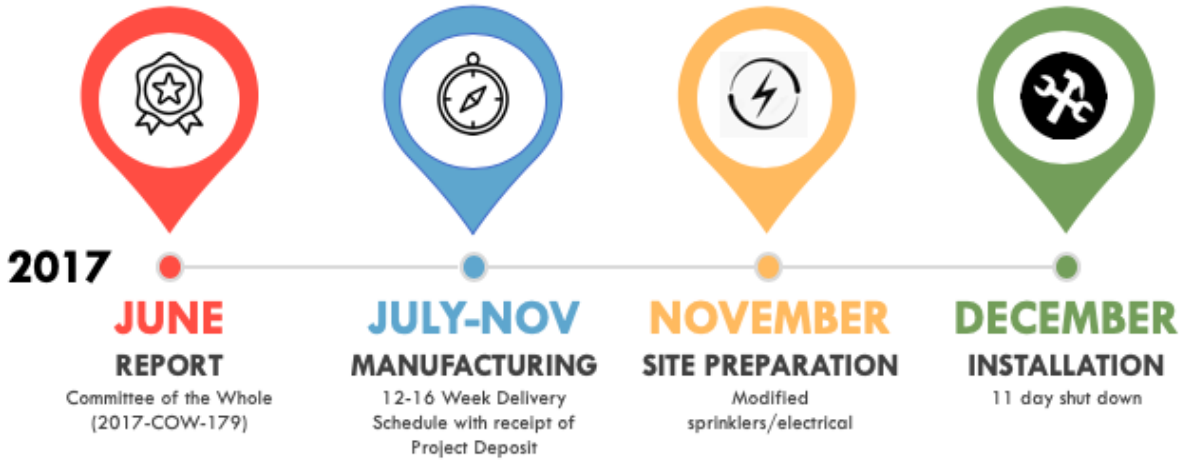
3. Approach

It was anticipated that a further MRF upgrade could capture more recyclables lost to residue. It was expected that approximately 1,000 tonnes of recyclables could be recovered from the MRF residue based on the historic lows of residue tonnes, whereas in 2013 there was 1,276 tonnes, compared to 2,322.7 tonnes in 2015. The reasoning for this increase coincides with when the container line shifted from a mechanical sort to a more manual sort because the two optical sorters were changed from dual ejecting to a single ejecting to better deal with the very high depth burden of plastics and increasing cross contamination. In addition, the Region also started accepting multi-residential recyclables at the MRF during this period, which significantly increased residue volumes.

Improving the capture of containers was anticipated to return annual cost savings to the MRF processing contractor in the form of reduced residue disposal costs of approximately $107,000 (1,000 tonnes x $107 haulage & disposal fee). It would increase revenues for the Region of approximately $189,000 (1,000 tonnes x 2016 $189 April CIF Container Composite Price Index Average).

3.1 Project Timeline and Implementation

The project timeline was as follows:



Report 2017-COW-179 to Committee of the Whole in June 2017 sought approval for the following:

- Amending and extending the existing processing contract with Miller with the inclusion of opt-out clause(s) in the last three-year extension periods to facilitate a timely transition to full Extended Producer Responsibility under the Resource Recovery and Circular Economy Act (RRCEA)

- Sole sourcing equipment upgrades project oversight to Miller (technical design, equipment specifications, equipment installation and commissioning)
- Sole sourcing the purchase of the required equipment from Machinex Recycling Systems to ensure compatibility with the existing Machinex components

The installation process required a full shutdown of the container line from December 1st to 12th, 2017. During this time, containers were unloaded and stockpiled at the old Durham's Recycling Centre's which sits adjacent to the MRF. The operation had no impact on the Fibres line which continued processing uninterrupted.

3.2 Overview of the New Container Line at Durham

The upgrades to conveyers and the addition of new equipment increased the MRF's processing rate from 6 tonnes per hour to 9.5 tonnes per hour – a 58% increase in throughput. A schematic drawing of the new container line system is provided in Figure 2 below. For a complete MRF processing diagram see Appendix C.

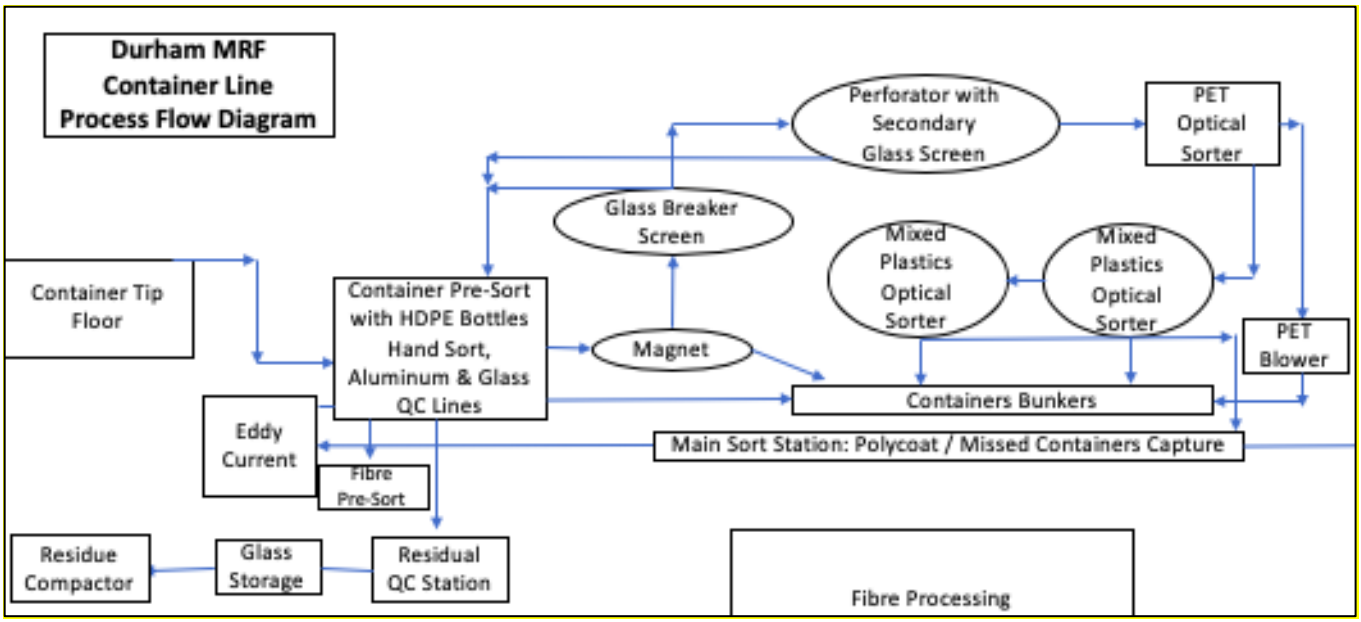


Figure 2: Durham MRF Container Line Diagram

3.2.1 Pre-Sort Line

Most contamination is positively hand sorted and removed at the beginning of the sorting process to ensure it does not interfere with the sorting equipment and sort stations downstream. Incoming loads of containers are emptied on the MRF's tip floor and large unacceptable materials, over-sized plastics, and film plastics are removed manually. Containers arriving in tied off clear plastic bags are also manually opened and emptied onto the tip floor by collection drivers or MRF staff.

Materials are then loaded into the inclining conveyor and moved to the pre-sort room. Recyclable fibres, large unacceptable items, over-sized plastics, and bagged materials are hand-sorted from the main line and dropped to a residue line and a fibre line. At the end of the pre-sort line, HDPE bottles are manually removed and dropped to a storage bunker below.

3.2.2 Sort Section 1 – Steel and Glass and Plastic Separation

Conveyors move the materials to a magnet and glass breaker (replacement for the original glass screen and heavy-light air cyclone). Steel is conveyed to a bunker. Glass is conveyed back to the pre-sort room for final quality control sorting before going to the indoor glass bunker.

3.2.3 Sort Section 2 – Plastics

The main line materials then move to the new high-volume plastics perforator which punctures bottles release any liquids and to allow for them to be better compacted. Another screen underneath the perforator captures any small and heavy items that may drop through the process. This allows for a secondary glass removal function.

Plastics are then moved to the new PET optical sort room which blows PET to a separate line and conveys the remaining materials forward on the main line. Prior to leaving the room, the PET line has a manual Quality Control station that removes any light material (film or paper) contaminants that may be blown off with the PET materials. Finished PET is air blown through a piping network to a newly expanded PET storage bunker.

The main line then proceeds through two Pellenc optical sorters which are currently set to single eject mixed plastics into bunkers and the remaining materials move to the main sort room.

In the main sort room, the focus is hand sorting aseptic/cartons, other non-aluminum recoverable containers, and any mixed plastics that may have been missed by the optical sorters.

3.2.4 Sort Section 3 – Aluminum

The process then involves an Eddy current separator which removes aluminum cans and foil. The aluminum line is conveyed back through the pre-sort room for QC and then dropped into a dedicated storage bunker.

3.2.5 Sort Section 4 – Residue Clean-Up

All residue lines combine to the residue QC station. This is the final attempt to remove any valuable materials from the sorting line prior to residue compaction and disposal. Scrap metals, mixed plastics, and mixed fibres are separated and dropped into cages below. Scrap metal is

taken to an outside 40-yard bin and the remaining mixed materials of fibre and plastics are recirculated back to the inbound tip areas.

It should be noted that several stations exist throughout the line to capture small electronics, hazardous materials (batteries and sharps), and automotive fluid containers.

3.3 Efficiency Upgrades Set-Up and Implementation

3.3.1 In-feed Conveyor

Prior to the upgrade the in-feed conveyor at the beginning of the container line had a relatively steep incline due to space limitations. The steep incline created the following problems:

- Materials rolled back, which increased the amount of time needed to convey all the materials onto the container line (i.e., lengthened operating hours required). This was more problematic in the winter months when the containers were frozen and heavier (ice and snow).
- Poor material distribution (i.e., black belt) was experienced at the pre-sort, meaning there was moments of time when no materials were on the belts to be sorted, which is an inefficient use of equipment, utilities and labour.
- Surges or piles of material of varying depth at the pre-sort, meaning manual sorters and equipment were unable to see buried materials, which resulted in missed capture and again inefficient use of the equipment utilities and labour.

A wider in-feed was installed which improved throughput and lessened material depth on belts for greater capture by hand sorters and equipment. The upgraded in-feed conveyor increased from 36 inches to 60 inches in width and increased the motor size from 5 horsepower to 7.5 horsepower.

Figure 3: In-Feed Conveyor Pre and Post Upgrade

3.3.2 New Glass Breaker

3.3.2.a. Rationale from Glass Screen to Glass Breaker

By 2017, the increasing number of loads of Durham's processed glass rejected by the Region's glass processor due to its Non-Glass Residue (NGR) was creating a significant cost issue to the Region. Much of the NGR was made up of the new, lightweight plastic containers containing food or liquids. The contents made the containers heavy, and they separated out with the glass, since the air separator cyclone operated by separating containers based on weight.

The air separator cyclone required frequent patch work due to the abrasive nature of glass circulating within it. This equipment also had a high tendency for jams at the perforator as containers evolved towards larger light weight packaging and bottles. The larger bottles had difficulty passing through the perforator which bottlenecked the container line operation.

Glass missed by the air separator cyclone was also increasing wear and tear on the downstream conveyor belts and equipment which increased downtime and equipment maintenance costs.

In light of the above, the Region elected to remove the air separator and the old glass screen and replace it with a new, more robust glass breaker unit.

3.3.2.b. Install Glass Breaker

Figure 4: Air Separator Cyclone and Glass Screen Before Removal

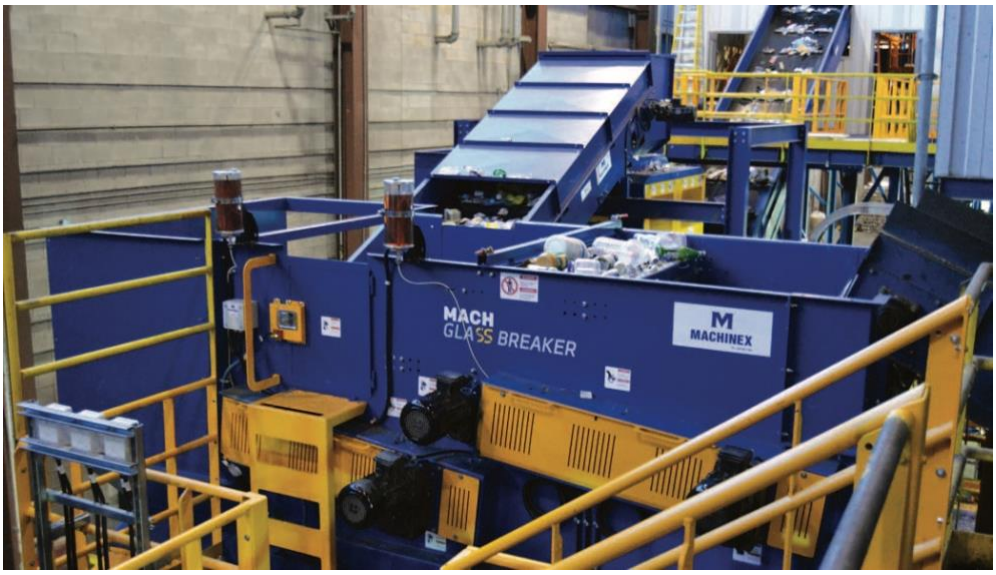


Figure 5: New Glass Breaker

3.3.2.c. Baseline Measurements/Return on Investment (ROI) Glass Breaker

The Region tracked rejected glass loads pre-post (costs), equipment downtown and maintenance costs to measure the impact of the new glass breaker. For detailed results see Section 0.

The implementation of the new glass breaker yielded the following:

- Glass screened out more effectively, less to no glass downstream in process (less maintenance, downtime and wear on baler and other equipment)
- No more liquid filled plastic bottles in glass from heavy/light separator
- Less rejected glass loads
- Improvement in useable glass shipped to Nexcyle
- No more full glass bottles, some minor increases in fines for end market

3.3.3 New Plastic Perforator

3.3.3.a. Rationale for New Plastic Perforator

The Durham MRF's throughput performance was challenged by the fact that it was not designed to handle the 29.1% overall increases in plastics tonnage and its associated volumes between 2012 and 2015. The heavy/light separator was not able to manage oversized plastics or 2 dimensional (flattened) containers which resulted in reduced throughput efficiency, increased cross contamination of various material streams, and the need for an additional shift of manual sorters.

To address these issues, the Region added a new 4 shaft, dual stage plastic perforator which increased the processing system's capacity and throughput of the new higher volume plastic containers and any other oversized plastics missed by the pre-sort operation. The perforator ultimately created 2-dimensional compacted containers which became easier for the optical sorting equipment to identify and sort as the compacted container materials remained stationary on the conveyor and was less likely to roll back. Further, the compacted materials increased bunker storage space and was easier to bale (less product memory). The perforator also provided a secondary glass screen for further glass capture.

3.3.3.b. Upgrade - New Plastic Perforator

Figure 6: New Plastic Perforator and Secondary Glass Screen

3.3.3.c. Baseline Measurements/Return on Investment (ROI) Plastic Perforator

The Region tracked throughput improvements to measure the impact of the plastic perforator. For detailed result see Section 0.

The implementation of the plastics perforator yielded the following:

- Secondary glass screening improved glass collection,
- Less to no glass downstream in process
- Less maintenance requirements
- Less downtime
- Less wear on baler and other equipment
- No more processed bottles with contents
- Higher processing “splatter” factor resulting in increased facility “cleaning” requirements
- Improved bunker storage densities of plastics
- Increased baler efficiency

3.3.4 New PET Optical Sorter

3.3.4.a. Rationale for New PET Optical Sorter

The Region's MRF was designed to sort PET and HDPE with 2 - dual eject Pellenc optical sorters. By 2016, increasing container volumes (39.2% PET – more thermoforms) had elevated the material burden on the main sort lines to the point that the optical sorters could no longer 'see' all the containers on their inbound conveyor lines which resulted in low PET capture rates. A revised approach was needed to manage the increased volumes and types of incoming plastics and the optical sorters were reprogrammed to operate in a single eject mode to increase their efficiency and reduce cross-contamination.

A new two-metre wide single-eject Machinex Mach Hyspec optical sorter was installed to target PET. The new optics speed belt minimized the depth burden on the main infeed conveyor belt and the wider belt accommodated the increased volume of materials throughput. Further, a new PET quality control manual sort station was installed after the optical unit to remove any contaminants from the optically ejected PET. Due to space limitations, a unique transport system involving an air blower and piping directs finished PET to an expanded bunker area.

3.3.4.b. Upgrade - New PET Optical Sorter

Figure 7: New PET Optical Sorter

3.3.4.c Baseline Measurements / ROI New PET Optical Sorter

The Region assessed throughput, tracked marketed material (pre-post in relation to inbound tonnage) and noted residual to measure the impact of the PET optical sorter. For detailed results see Section 0.

The implementation of the PET optical has yielded the following:

- Increased throughput of containers from approximately 6 tonne/hr to 9.5 tonne/hr (See Letter in Appendix D)
- Produced better quality and quantity of materials for end markets. No issues have been raised by buyers, specifications are being met, and marketing has continued without any concerns.
- Wider in-feed conveyor from 48 inches to 60 inches with higher cleats resulting in less material roll back. Conveyor motor increased from 5 to 7.5 horsepower.

- Removed large component of container stream for more efficient and effective processing downstream and significantly lowered the depth burden on the line.

3.4 Project Challenges and Solutions

The composition of blue box materials continues to shift in favour of containers over paper fibers. The MRF contractor has suggested that the main reasons include:

- poor quality of incoming Multi-Residential tonnages
- growing residential "wish-cycling" of non-recyclable plastics inputs, and
- additional immigration of residents from single-stream municipalities leading to increases in cross-contamination In Durham's dual-stream system.

Although the upgrades to the system demonstrated efficiency improvements, some key set-up problems were experienced and are outlined in Table 3.

Table 3: Summary of Set Up and Implementation Challenges

Key Set Up Problems and Implementation Challenges	**Solution Implemented**
Perforator can shatter ridged plastics when cold, and pop off bottle caps leading to some contamination in the glass stream from the secondary screen under perforator and from overflow of the overhead conveyor belt belly pan	• Continuous tracking with annual MBG audits • Increased cleaning of belly pan
New glass breaker has eliminated occurrence of bottles being sent to market but has increased the amount of glass fines somewhat to end market	• Continuous tracking with annual MBG audits
Pre-mature tooth wear on perforator	• Fixed under warranty
Perforator is releasing aerosol can contents into PET optic sorter enclosure	• Fan installed; • Staff wear respirators
Glass Breaker and Perforator increased "splatter" factor	• Ongoing and increased cleaning around equipment
HDPE – After upgrade, HDPE material (bottles and tubs and lids) were sorted by a Pellenc optical sorter which resulted in a degradation of HDPE materials and bales were no longer considered "bottle grade". MRF operator re-instituted hand sorting stations to maximize market value of HDPE.	• Implemented hand-sorting stations in pre-sort room and mixed plastics in residue QC
Increased wearing at elbow on the PET air piping system.	• Replaced section of piping as required

4. Project Results and Analysis

4.1 Project Results

The Region experienced the following results after the redesign/upgrade features described in this report:

- Increased effectiveness and efficiency of recyclable plastics processing;
- Decreased operational costs of plastics recycling;
- Improved container system throughput (tonnes/hr);
- Labour savings throughout the system for MRF contractor;
- Reduced unscheduled downtime;
- Reduced equipment maintenance requirements and cost to contractor
- Reduced processing backlogs;
- Reduced hand sorting of PET and mixed plastics on main sort as both these materials are optically sorted;
- Reintroduction of manual sorting stations for HDPE as a result of request for higher bottle grade market specifications from buyers;
- Improved the quality and marketability of plastic resulting in increased revenues;
- Improved the quality and marketability of glass stream resulting in decreased rejected load costs;
- Improved capture of targeted materials (increased diversion) and;
- Improved container bunker storage space from plastic container perforation and expanded PET bunker.

It was anticipated that the upgrades would also reduce residue however, this outcome was not realized.

The Region monitored the following aspects pre and post installation to quantify the impact of the system redesign/upgrade and performance of the new equipment:

- Container line material throughput (tonne/hr);
- Staffing levels;
- Maintenance requirements;
- Unscheduled downtime;
- Market revenues based on improved volume and capture rates;
- Feedback from material plastic buyers on quality – marketed tonnage;
- Residue tonnage.

4.2 Analysis of Results

4.2.1 Container Line Productivity, Maintenance, and Downtime

The MRF container line operated 5 days a week and 15 hours per day over two shifts to handle the volume increases discussed above before the system upgrades.

After the retrofit, the container line required only one shift per day to process containers. This represents 43% less operating time (15 hours down to 8.5 hours) and 58% increase in hourly throughput (from 6 tonnes per hour to 9.5 tonnes per hour). The elimination of the second shift and the associated labour and operating savings better positioned the Region to negotiate a new contract extension with the existing contractor Miller Waste (See Table 4).

Table 4: Labour and Operating Estimated Savings Pre-Post Upgrade

	Number of Positions	Average Cost/Hr	Hrs / Week Saved	Total Savings for 52 weeks
Labour				
Sorters/Operators/Maintenance/Supervisors	18	$22	20	$411,840
Operating				
Equipment: Loader, Fork Lift, Conveyors		$44	68	$155,584
Hydro, Safety/Uniform Costs, Miscellaneous contractual costs				$162,000
Total Estimated Savings	**$729,424**			

The above table is based on estimated cost avoidance associated with an anticipated contract extension negotiation.

Several maintenance issues existed prior to the retrofits. Following the upgrades, the reduction in operating hours overall meant less wear and tear on the sorting equipment per day. The following table outlines the percentage and total hours associated with downtime on the container line pre and post upgrade. When comparing the downtime, since the upgrades there was 0.03 hours less downtime (an estimated 15.3 minutes per day) which is equal to a 28.6% reduction.

Table 5: Container Line Downtime Pre and Post Upgrades

Time	**Downtown (percentage)**	**Total Hours**
Prior to upgrades	10.5% on 15 hour working shift	0.105 hours (estimated 94.5 minutes per day)
After upgrades	7.5% on 8.5 hour working shift	0.075 hours (estimated 38.3 minutes per day)
Overall		**15.3 minutes per day (28.6% less downtime)**

Unfortunately, due to complications of lost data from a computer virus, the contractor is unable to provide records for maintenance and costs of associated equipment pre and post upgrade.

4.2.2 Material Tonnage Capture, Processing Expenses and Revenue

Figure 8 shows that the composition of inbound materials continues to shift with inbound tonnage decreasing by 2% and container composition increasing to 32.8% (2.1% more than 2017).

	Stream Percentages	
Stream	**2017**	**2018**
Newspaper	51.3%	47.6%
Mixed Paper	2.6%	3.5%
Cardboard	15.4%	16.1%
Fibre Composition	**69.3%**	**67.2%**
Aluminum	1.4%	1.4%
Steel	3.4%	3.0%
PET Plastic	5.2%	6.3%
HDPE Plastic	1.3%	0.9%
Mixed Plastic	2.5%	3.1%
Gabletop/Polycoat	0.6%	0.5%
Glass	9.2%	9.7%
Residue	7.2%	8.0%
Container Composition	**30.7%**	**32.8%**
Inbound Tonnes	**47,839.1**	**46,906.1**
Marketed Tonnes	**43,390.2**	**43,277.1**
Residual Tonnes	**3,361.0**	**3,768.0**

Figure 8: Inbound Material Composition 2017-2018

Several improvements in tonnage capture were noted after the upgrades. As shown in

Table 6 and Figure 9, the plastics materials targeted by the upgrades, chiefly PET and mixed plastics, had large gains from 2017 to 2018 with increases of 22% each. Glass capture also increased by 6% year over year.

Table 6: Container Tonnage Processed 2017 versus 2018

Year	Alum	Steel	PET	HD	Mixed Plastics	Gabletop Polycoat	Glass	Residue	**Total**
2017	632.01	1,478.53	2,433.25	586.10	1,186.56	277.14	4,283.75	3,359.00	**14,236.34**
2018	654.77	1,259.56	2,972.45	413.89	1,446.70	234.95	4,547.92	3,767.60	**15,297.84**
Change	4%	-15%	22%	-29%	22%	-15%	6%	12%	**7%**

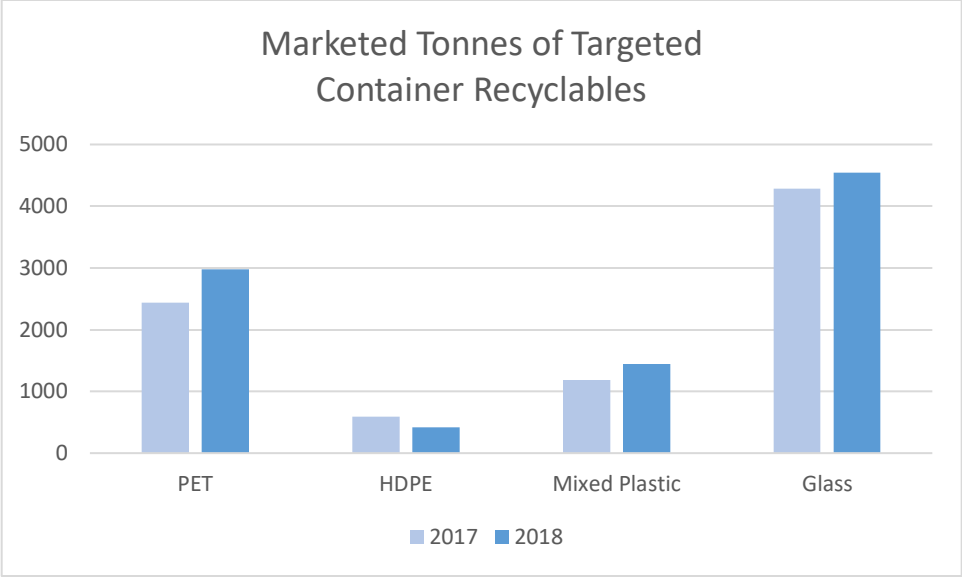


Figure 9: Marketed Tonnes for Targeted Containers

According to Figure 10, the bales of material shipped have increased for PET and Mixed Plastic when comparing 2017 and 2018 despite the decrease in inbound tonnage. This suggests that more of these materials have been captured in the newly upgraded system. As an additional benefit, aluminum capture has also increased. Since the eddy current is last on container line, it is suspected that less depth burden has improved its capture efficiency.

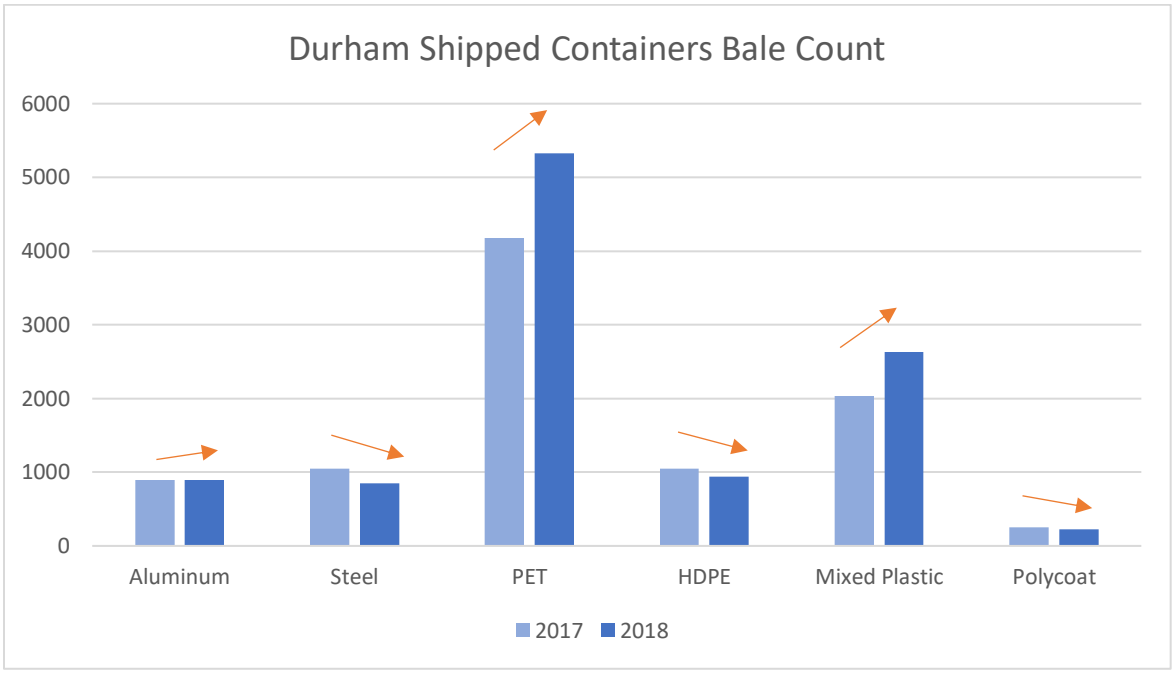


Figure 10: Container Bale Counts 2017-2018

Marketed container tonnage overall increased by 6% between 2017 and 2018 (see Figure 11) and the Region has not had any load rejections or downgrades from buyers.

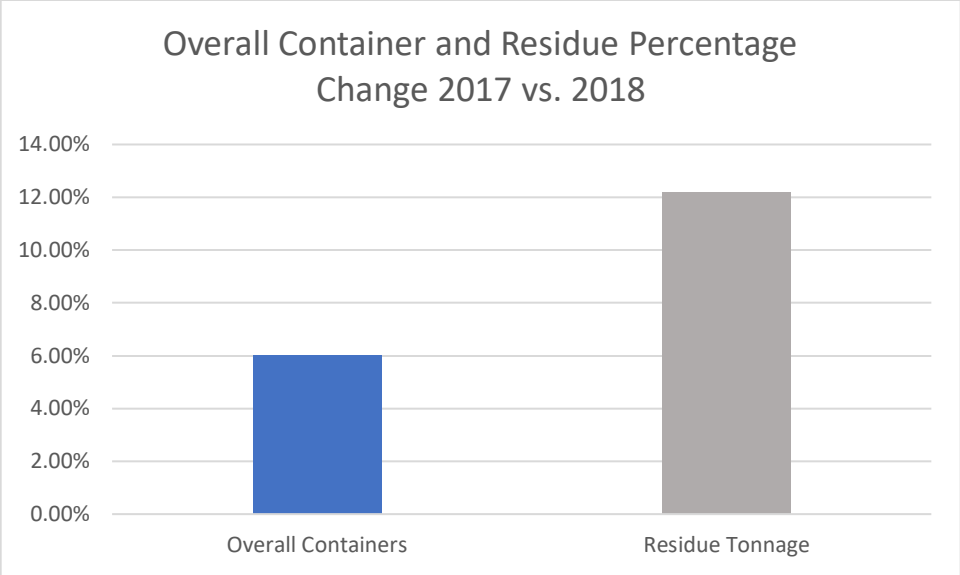


Figure 11: Overall Container and Residue Change

Unexpectedly, processed residue tonnage increased by 12.2% (fibres and containers combined). When reviewing the ratio of residue to containers the rate of increase was 4.83%. No specific processing residue audit information is available, however it is suspected that since October 2013 the MRF started to process multi-residential buildings recycling and this has increased the MRF residue rate.

A comparison to 2017-18 CIF/SO waste composition studies in three similar dual-stream recycling systems shows that non-acceptable materials in the blue box have risen by 23% and the total kg/hh/week of has declined by 2.8% which indicates that similar contamination increases are occurring in other municipalities across Ontario.

As outlined in Table 7 below, the number of shipped loads of Mixed Broken Glass (MBG) declined by 14.4%. However, the changes to the glass system at the Durham MRF have resulted in:

- increased MBG marketed tonnes (5.8%),
- decreased outputs of non-recyclable glass (13.9%), and
- reduced back haulage fees (saving $4,200).

Table 7: Mixed Broken Glass Summary Table

Year	Marketed Tonnes	# of Loads Shipped	Rejected Loads	Annual Avg. -3/8%	Annual Avg. +3/8%	Annual Avg. NGR%	Total backhaul costs
2017	4,284	143	16 loads	12.42%	65.50%	21.42%	$5,600
2018	4,548	125	4 loads	13.48%	67.63%	18.45%	$1,400
Change	**5.8%**	**-14.4%**	**-12 loads (-300%)**	**8.5%**	**3.3%**	**-13.9%**	**-$4,200**

The change in MBG sizing has been attributed to the effectiveness of the new glass breaker. It is been suggested that less “full bottles”, taking up space in the system, may have improved the payload of MBG on shipments and could explain the increased tonnage with decreased loads shipped.

Based on the average yearly 2018 CIF Container Composite Index and increased tonnage of plastics on the containers line, $156,043 in additional revenue was generated for the Region of Durham (See Table 8).

Table 8: Container Revenue Summary

Material	Yearly Average Price Per Tonne (CIF – Price Sheet Dec 2018)	Increased Tonnage (2017-18)	Additional Revenue
PET	$429	542.2	$232,603.80
Mixed Plastic	$0	260.10	$0
HDPE	$483	-172.21	-$83,177.43
Glass	-$41	264.17	-$10,830.97
Overall Containers	**$239**	**652.90**	**$156,043.10**

4.3 Lessons Learned

Ongoing tracking of MRF productivity-costs
Implementing process flow audits would allow baselines performance metrics to be established so that any changes can be measured to see if forecasted improvements are achieved. For this project, it would have been beneficial to track percentage capture of materials (at optical sorters and recirculated from residue QC) to confirm the performance of the new equipment.

Project administration
Allowing the existing contractor to take responsibility on the upgrades respected the existing working relationship between the municipality and the contractor as well as saved municipal staff resources.

Single sourcing equipment
Being able to purchase from one manufacturer allowed for prompt procurement as well as consistency with other equipment within the MRF.

Contractor Backup Information
During project reporting, information on equipment maintenance and costs and residue audits were challenged due to the contractors compromised digital filing system. It is suggested that the Region request backup reports on all MRF operations for ongoing tracking purposes.

5. Project Budget and Realized Savings

Table 9: Project Costs

	Budget	Cost
Design, Plan & Equipment	$1,532,227	$1,591,649.00
Commissioning, Testing, Project Management	$303,000	$408,400.00
Contingency, 10%	$30,000	n/a
Total Project Cost	**$2,041,746**	**$2,000,049.00**
CIF Funding (42%)	$857,534	$840,020.58

Table 10: Project Realized Savings and Estimated Return on Investment

	Projection	Realized Savings
Revenue Improved line will result in better capture of materials and 50% reduction to the number of marketable tonnes lost to residue. Revenue from 25.43 tonnes of old equipment sold for scrap metal was included in final savings ($5,950.37)	$190,000	$156,043
Avoided costs (estimated under contract) Elimination of the need for a second shift - Labour - Hydro - Misc. staff related costs	$729,424	$729,424
Total Revenue and Avoided Costs	$919,424	$891,417
Calculated Return on Investment	**2.2 years**	**2.2 years**

6. Conclusion

The Region of Durham undertook MRF container line upgrades to avoid anticipated contract costs with a looming November 2019 contract end date. The upgrades allowed for positive negotiations with Miller resulting in extending the existing contract from November 2017 to November 2019 with an optional three-year extension until 2022.

The upgrades have increased captures of targeted containers resulting in additional revenue. The new equipment has resulted in avoided second shift expenditures, decreased downtime, and improved material quality. Therefore, the goals and objectives of the project were achieved.

The upgrades took place in 2017 and consequently tonnage has stabilized due to paper dropping (digital age), however OCC is increasing due to online shopping (amazon effect).

Containers fluctuate and inbound tonnage is flat but increases in capture was realized after the upgrade specifically in PET, mixed plastics and aluminum.

The Region anticipates that tonnage will grow with population increases and has identified capital improvements, from a recent equipment assessment, replacing six conveyors (mainly original pieces of equipment from 2007). This demonstrates that the upgrades have prepared the Region for projected changes in container processing and aligns operations for future opportunities and challenges in container composition.

Appendix A- Optimization of Regional Solid Waste Management

Standardized Service: Common Solid Waste Management Property Tax Rates

7. Based upon the achievement of standardized Regional Solid Waste collection services, the Regional Solid Waste Property Tax Rates commencing in 2009 and phased in over a three year period, be based upon standardized services and uniform Regional Property Tax rate calculations based upon weighted assessment, with impacts as noted herein, and based on the following benefits:

   i. Consistency with taxation for other Regional services;
   ii. Increased transparency and accountability to stakeholders;
   iii. Reduced swings in year-to-year, and municipality-to-municipality, tax requirements;
   iv. Removal of any tax impact disincentives to engaging in higher cost but beneficial future environmental/diversion programs approved by Regional Council;
   v. Region-wide assessment growth impacts will not penalize slower-growth municipalities, or municipalities facing large assessment appeals, in a given year; and,
   vi. A greater ability for the Region to finance future potentially more costly diversion programs to achieve the 70% diversion target.

Optimization of Regional Solid Waste Management Infrastructure

8. Regional Works and Finance staff be authorized to investigate opportunities to optimize the use of existing infrastructure and programs, which may create efficiencies across municipalities and various stakeholders groups, with subsequent reporting back to Regional Council, regarding opportunities, including:

   i. The Commissioners of Works and Finance, be authorized to approve sale(s) of surplus recycling processing capacity at the Durham Region MRF, subject to:
   - The sale of surplus capacity not compromising current or future processing capacity requirements of the Region;
   - Accepting only recyclable materials of sufficient quality to not compromise the marketability of Regional materials also processed at the facility; and,
   - Surplus capacity utilization being reasonably priced at a net cost which includes coverage of all calculated Regional administration, capital, and operating costs, plus a reasonable return to the Region's taxpayers, sufficient to provide adequate coverage for future equipment replacement costs attributed to the sale of surplus capacity.

Appendix B- Contractor Agreement RFP 168-2012

5.17 Hot Beverage Containers

The Region may choose to expand the current program to include hot beverage containers. Respondents shall provide pricing is Appendix A, Form of Proposal, Pricing Scenario #3 to process/recover this material from the incoming container stream.

Hot beverage containers shall be baled as per the market specifications provided in Attachment H.

5.18 General Operations Requirements

The Contractor shall be required to manage and perform the functions associated with the Operations and Maintenance of the Facility.

The Operations of the Facility includes, but shall not be limited to:

- Receiving and processing Dual Stream recyclable materials;
- Minimizing the quality and quantity of residue;
- Producing and shipping Recovered Materials;
- Meeting required Market Specifications;
- Disposing of residue;
- Maintaining plant equipment;
- Maintaining and cleaning the building, processing equipment and the Site; and
- Quality control and quality assurance of Recovered Materials.

The Region is continually seeking to increase waste diversion rates, improve the capacity of the Facility and improve the quality of the Recovered Materials. The facility and the Contractor will be required to participate in studies, tests, evaluations and audits from time to time as required by the Region. The Contractor will co-operate fully and assist in all efforts related to the achievement of these goals.

5.19 Third Party Recyclable Materials

The Region reserves the right at is sole and ultimate discretion at any time throughout the term of this contract, to solicit any unused processing capacity of the MRF to other municipalities or other third parties. The Contractor shall engage the Region in good faith negotiations for the processing of this material.

5.20 Household Hazardous Waste

Although the Region advises residents not to place Household Hazardous Waste (HHW) into Blue Boxes, from time to time small amounts of unsolicited HHW are received at the MRF. The Contractor shall remove, isolate and segregate all HHW and place it into a storage container that will be provided by the Region and placed on site in a mutually agreed upon location.

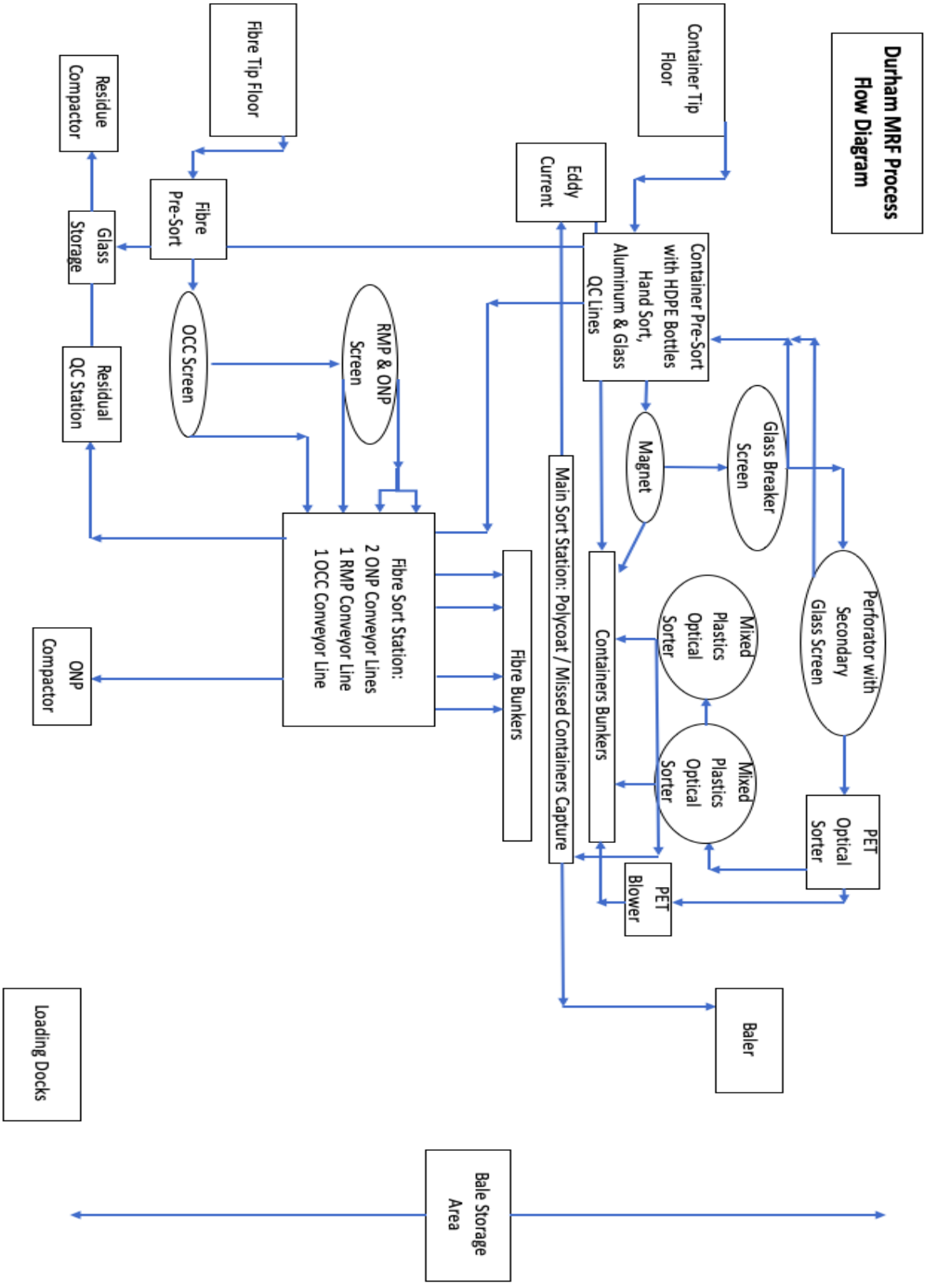
All HHW material shall be stored upright.

Under no circumstances shall the Contractor include or mix non-recyclable material with the HHW in the storage container.

The Contractor shall notify the Region when removal of HHW is required.

All handling and storage of HHW shall be in compliance with all applicable guidelines and regulations such as, but not limited to:

Appendix C – Flow Diagram of Durham MRF



Appendix D – Letter regarding Container Line Performance

Miller Waste Systems Inc.
8050 Woodbine Avenue
Markham, Ontario L3R 2N8
E-mail: millerwaste@millergroup.ca

Tel: (905) 475-6356
Fax: (905) 475-6396

December 28, 2017

VIA EMAIL: Steven.Jedinak@Durham.ca

Mr. Steven Jedinak
The Region of Durham - Solid Waste Department
4600 Garrard Road
Whitby, Ontario
L1R 3K8

Dear Mr. Jedinak:

Re: MRF Container Line Process Equipment Retrofit & Upgrade

Miller Waste Staff in both the operations and engineering departments supervised the Machinex Process Equipment Commissioning between December 12th to 14th of this year at the Durham MRF.

Upon reviewing the attached Machinex letter and reviewing the calculations, supporting documentation, Miller is in agreeance with their findings that the new equipment is not only meeting but also exceeding the guarantees that was placed upon them.

It is Miller's opinion that this has been an extremely successful project and that there is no reason to hold back any further payments to Machinex.

Yours very truly,
MILLER WASTE SYSTEMS

Adrian Kleywegt, P.Eng.
Project Engineer

Rodney Libby,
Facilities Operation Manager

MACHINEX

Plessisville, December 28th 2017

Mr. Rodney Libby

Miller Waste Systems
District Manager – Facilities

Mr. Libby

As discussed with our Start-up supervisor Guy Legaré, here are the throughput result for the Durham system. You will find that the results are in-line with the contract with Durham Region asking for a 9T/h throughput.

Test #1
3.13 tons in 17 minutes
Date: 2017-12-12
11.05 t/h
2 trucks (all compacted material) truck number 162376 and 162380
C-31 VFD adjustment at 60%

Test #2
1.95 tons in 12 minutes 32 seconds
Date: 2017-12-13
9.34 t/h
2 trucks (1 round and 1 compacted) truck number 800010 and 92210
C-31 VFD adjustment at 68%

Test #3
1.99 tons in 12 minutes 3 seconds
Date: 2017-12-13
9.55 t/h
2 trucks (1 round and 1 compacted) truck number 162376 and 162380
C-31 VFD adjustment at 68%

INDUSTRIES MACHINEX INC.

2121, rue Olivier, Plessisville, Québec G6L 3G9, CANADA
Tél. : +1 (819) 362-3281 / Fax : +1 (819) 362-2280 / info@machinex.ca
www.machinex.ca

MACHINEX

Test #4
2.45 tons in 16 minutes 2 seconds
Date: 2017-12-14
9.02 t/h
2 trucks (1 round and 1 compacted) truck number 800014 and 162371
C-31 VFD adjustment at 68%

Test #5
1.96 tons in 13 minutes 21 seconds
Date: 2017-12-14
8.81 t/h
2 trucks (1 round and 1 compacted) truck number 92210 and 800012
C-31 VFD adjustment at 68%

For an average of **9.55 Tonnes/Hours**

If you have any further questions, please do not hesitate to contact me

Jean-François Arbour, ing. / P.Eng
Gestionnaire de projets / Project Manager

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