TECHNICAL AND ECONOMIC ANALYSIS OF THE NEW YORK CITY RECYCLING SYSTEM

by

Claire E. Todd

Advisor: Professor Nickolas J. Themelis

Department of Earth and Environmental Engineering
Fu Foundation of Engineering and Applied Science
Columbia University

May 2002

Research sponsored by the

EARTH ENGINEERING
Center
Columbia University

Technical and Economic Analysis of the New York City Recycling System

Claire Todd

EXECUTIVE SUMMARY

This study is part of Columbia's Earth Engineering Center (EEC) continued effort to develop and promote improved municipal solid waste (MSW) management in urban centers. This report first assesses the effectiveness of New York's current recycling situation based on tours taken of sorting and recycling facilities contracted by the New York City Department of Sanitation (NYCDOS). On the basis of this assessment and studies of successful municipal recycling programs across the country, recommendations are made for improving the cost efficiency and recovery of the New York City Recycling Program.

In 1999, NYC DOS collected 393,142 tons of paper and 278,393 tons of commingled metal, glass, and plastic (MGP). Mayor Bloomberg recently announced that although the paper stream is cost efficient, the MGP stream cost the City an average of $230 per ton. Although recovery of valuable resources might justify this added cost, tours and interviews at MGP recycling facilities revealed that as little as 40% of the MGP collected is actually sold for recycling and reuse. New York City recyclers struggle to sell most of the recovered materials, in particular mixed broken glass which accounts for up to 50% of the weight of delivered materials. Due to the low market values of the recycled materials, the MGP recyclers owned by smaller companies are unable to invest in automated separation technology that could potentially increase recovery.

In contrast to New York City, successful recycling programs around the country share one common trait: Local government investment in recycling infrastructure and management. This project reviews two alternative programs for improving the economics and the recovery rates of New York City recycling. First, commingled collection and processing of recyclable material is evaluated based on the experience and performance of a single-stream MRF in Phoenix, Arizona and the study of former EEC research associate, Alex Dubanowitz. Second, co-collection of source-separated recyclable material and MSW is reviewed based on the results of Chicago's Blue Bag Recycling program. Recovery rates from each city are applied to New York City MSW and compared with recoveries achieved through the current recycling program. The results of this study show that a co-collection program as implemented in Chicago could not match current material recovery rates. However, projected costs and recoveries from Phoenix data indicate that construction of a city-owned single-stream MRF and collection of a commingled stream would result in higher capture and diversion rates than currently achieved at a net economic benefit of at least $30 per diverted ton. While this proposal requires an extraordinary effort on the part of the city government, our research shows that a city-owned materials recovery facility is necessary to improve recycling in New York City.

Acknowledgements

First and foremost, I would like to thank Professor Themelis for his invaluable support and guidance throughout my stay in the Department of Earth and Environmental Engineering. Several people in the waste management community have been especially helpful including Robert Lange and Susan Cohen of New York City's Bureau of Waste Prevention, Reuse and Recycling, Carl Smith of City of Phoenix Public Works Department, John Ryberg of Palm Beach Solid Waste Authority, Tara Hemmer of Waste Management, Michael Lobosco of A & R Lobosco, Chris Buchanan of Hunts Point Recycling, Fred Sears of Triboro Fibers, Taylor Pyne and Anthony Tristani of Rapid Recycling Paper Corporation, Muneer Ahmad and Judy Goodstein at Visy Paper, Nathiel Egosi of Resource Recovery Technologies, and Professor Daniel Walsh of the New York State Department of Environmental Conservation.

I would also like to recognize the invaluable support of Ko Matsunaga, Alex Klein, Joe Di Dio, Liliana Themelis, Jaime Bradstreet, and Barbara Algin from Columbia's Department of Earth and Environmental Engineering. Finally, I would like to thank my family for their unfailing encouragement and guidance throughout my academic career.

Table of Contents

List of Tables

List of Figures

1. Introduction

New York City Department of Sanitation (NYC DOS) manages the largest municipal solid waste stream in the United States, collecting a total of 5,211,437 tons in 1999.[1] With 23,705 people per square mile, DOS collection vehicles service the densest residential area in the country.[2] These factors coupled with the 2001 closure of the city's only landfill have created a unique waste management challenge. The City now exports more than half of its waste stream to out-of-state landfills at great cost to the city. An increasing number of city officials and residents are examining waste management alternatives in an effort to not only save taxpayers money but also to avoid some of the environmental impacts of transporting and landfilling nearly three million tons of waste each year.[1] This report evaluates the potential of residential recycling as an economically viable means to recover recyclable material and reduce the amount of waste exported to landfills.

Curbside pickup of residential recyclables is not new to New Yorkers. In 1989, Local Law 19 effectively established the New York City curbside recycling program by mandating the recovery of at least 4,250 tons per year by 1994.[1] Today, the material collected by NYC DOS is the largest city-managed recyclable stream in the nation, and New York is the only U. S. city offering public curbside collection of recyclables to all residents in single and multi-family housing as well as to some institutions.[3]

Despite the impressive expansion of the recycling program throughout 1990s, the City has faced much criticism and even legal challenges for the rates of diversion reported by DOS. Environmental groups such as the Natural Resources Defense Council argue that the Department's policy of counting all material collected at the curb as "diverted" is inaccurate and overestimates the amount of material actually recovered. A 1997 lawsuit charged the City with failing to reach the mandated recovery, despite above-target diversion rates reported by DOS. These accusations arose from the discovery that as much as 60% of the metal, glass, and plastic (MGP) stream delivered to private recyclers in the city could not be sold for reuse. While the debate still continues about the exact definition of "diversion rate," this study confirms what environmentalists have been

[1] New York City Office of the Comptroller Bureau of Management Audit 2001
[2] New York City Department of Sanitation 2001
[3] Biddle 2001

asserting for several years: a significant fraction of the material collected curbside is not recycled into consumer products.

Even if diversion rates are actually lower than reported, DOS data still indicate an upward trend in the percent of material recovered from the paper and MGP streams. However, these increases are largely due to expansions in the program to provide weekly collection to all districts in the city.[4] Only since April 2000 has the program offered consistent weekly collection of recyclable material in all waste-collection districts. Establishing citywide curbside collection of recyclables in a city the size of New York was an ambitious goal, and the City and DOS should be applauded for this achievement. However, it is incorrect to assume that increased diversion can continue once citywide service has been established. A 1998 article in *BioCycle*, a nationally known waste management publication, recognized a common theme among municipal recycling programs[5]: "Unfortunately, in all too many cases, recycling program participation and diversion rates can stagnate due to a host of technical, political, and cultural reasons. Such stagnation can keep collection costs higher than anticipated and can limit economies of scale due to throughput that never materializes."

It is the economic factor and the September 11th disaster that has again brought the recycling program to the forefront of city politics. In February of 2002, Mayor Michael Bloomberg unveiled an aggressive budget plan designed to close a budget gap estimated at as much as five billion dollars. The suspension of the MGP recycling program was one of the proposed cost-cutting measures. In the words of the Mayor: "We have two recycling programs: one that works, and one that does not. We're going to propose closing the one that does not temporarily, until we can find a better solution."[6] That "better solution" is the motivation behind this study's evaluation of potential alternatives to the current New York City recycling program.

Like New York, many U. S. cities in the late 1980's responded to decreasing local landfill capacity and to public opinion by launching municipal recycling programs. As part of this effort, some governments established publicly-owned materials recovery facilities (MRFs) to handle the material diverted from municipal solid waste (MSW).

[4] New York City Independent Budget Office (NYC IBO) 2001
[5] Biddle 1998
[6] Bloomberg 2002

While some material recovery technology such as magnetic separation is common to all of these facilities, MRFs can be designed in different ways to accommodate a variety of collection schemes. This project reviews collection schemes and the resulting MRFs in two U. S. cities: Chicago and Phoenix. Recovery rates and costs from each scenario will be applied to New York City's waste stream for the purpose of evaluation and comparison to the current recycling program.

2. The Current New York City Recycling Program

2.1 Overview

The New York City Recycling Program includes two separate collections and processes: metal, glass, and plastic (MGP) recycling and paper recycling. In 1999, the city collected a total of 671,535 tons of residential recyclables. Forty-one percent, 278,393 tons, of the collected material was MGP, and the remaining fifty-nine percent was paper. The city diverted an additional 837,612 tons of "other waste" such as food and construction waste.[7] Many cities implement programs to recover non-residential waste, but there is wide variety in the types of material targeted and in the

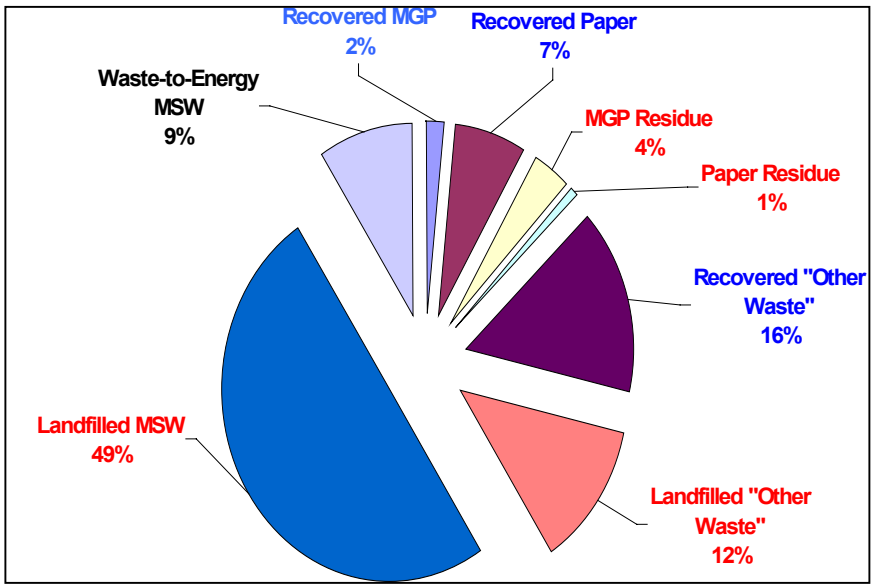


Figure 2.1 Fate of DOS-managed New York City MSW.[78]

[7]NYC Office of the Comptroller Bureau of Management Audit 2001
[8]NYC Independent Budget Office 2001

manner of collection used. These discrepancies make it difficult to formulate a valuable comparison between such programs, and thus material recovered outside of curbside recycling programs will not be included in this study.

Figure 2.1 shows the distribution of all waste collected by the Department of Sanitation. Although the Department reported a citywide residential diversion rate of 17.9% in 1999, the graph above shows that material recovered from residential recyclables accounts for only 9% of the total waste stream. The following sections review both paper and MGP recyclers contracted by the city in order to identify strategies that will increase the amount of residential recyclable material diverted and recovered from New York City MSW.

2.2 Paper Recycling

Paper constitutes the bulk of recycled material collected by NYC DOS. In 1999, DOS collected and delivered 393,142 tons of paper, i.e. 59% of all municipal recyclables collected. Despite depressed markets, New York City's paper recyclers maintain very steady and saleable recoveries, relying on international and domestic paper markets to absorb the recovered material. Although the city's formal recycling program as recognized today began in the 1990s, the paper recycling industry has been well-established in the City for nearly three decades.

In 1999, the city contracted five recycling facilities to process municipal paper recyclables. Four of these companies received an average of $15 per ton of DOS-delivered recyclable paper. These companies must sort and bale the paper stream to produce material worthy of sale to paper mills. In contrast, the fifth company, Visy Paper, is a paper mill with an on-site pulper capable of processing loose, unsorted material. Visy produces paper directly from DOS-delivered material without any presorting or separation. The plant also receives approximately the same amount of material from commercial sources, mostly old corrugated cardboard (OCC). The ratio of DOS-delivered mixed paper and OCC processed simultaneously in the pulper varies with the grade of paper being produced. In 1999, Visy Paper received 129,380 tons of mixed paper and paid New York City an average of $15 dollars per ton of material delivered.[9] In January

[9] NYC Office of the Comptroller Bureau of Management Audit 2001

2002, The Official Board Markets were reporting the following prices in the New York region: $20-25/ton of mixed paper, $35-40/ton of OCC, and $25-30/ton and $40-45/ton of #6 and #8 news, respectively. Newspaper grades range from #6 to #8, with higher numbers indicating a greater percentage of newspaper content.

NYC DOS reports the composition of the paper stream as shown in Figure 2.2. Contracted paper recyclers report the slightly different percentages represented in Figure 2.3, but all recyclers acknowledge the presence of a residual stream containing mostly plastic films. Recycling facilities report percentages of this residue ranging from 5 to 10%. Newspaper content is generally lower than reported by DOS, ranging from 55 – 60% of the delivered paper. Few paper recyclers attempt to recover any mixed paper material due to low market value. Mixed paper material is generally included in a #7/8 news stream; news and cardboard represent most of the material recovered and sold by New York City paper recyclers.

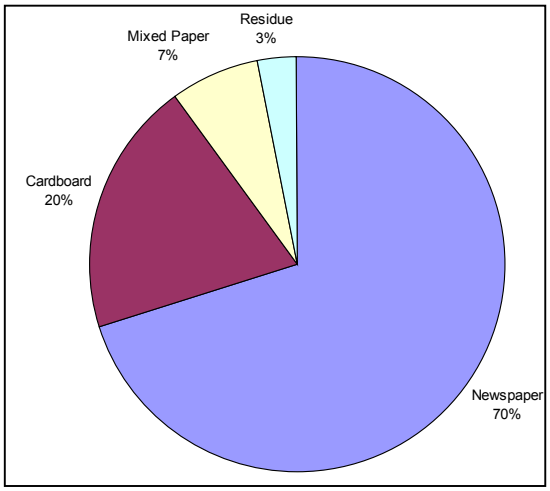
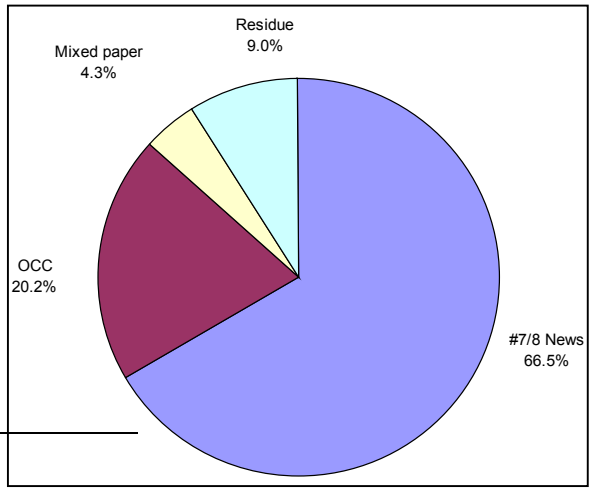


Figure 2.2 DOS-reported composition of collected recyclable paper[10]



[10] NYC DOS 1995

Figure 2.3 Composition of recyclable paper, as reported by contracted recyclers[11]

2.3 Metal, Glass, and Plastic Recycling

As noted earlier, the City delivers approximately 280,000 tons per year of curbside commingled metal, glass and plastic to four different recycling facilities. Figure 2.4 shows the composition of the DOS-collected MGP stream, as reported by the Bureau of Waste Prevention, Recycling and Reuse (BWPRR) of DOS.

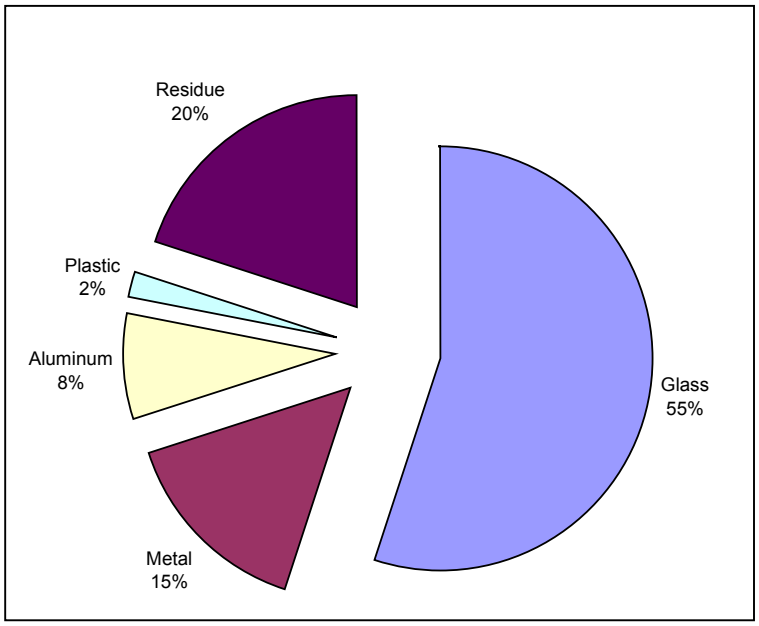


Figure 2.4: DOS-reported composition of collected MGP stream[12]

However, these numbers are slightly misleading. The glass fraction reported here is numerically correct, but the representation of glass as a recovered stream is incorrect. Most of the glass fraction of the DOS-delivered stream is mixed broken glass contaminated with dirt and small pieces of metal and plastic. MGP recyclers have to dispose of this material at cost by sending the material to a landfill for direct disposal or by pulverizing it and disposing it for use as an alternative grading material if it is pulverized.

[11] Data collected from tours and interviews with contracted recyclers in February 2002
[12] NYC DOS 1995

Of the four recycling facilities processing DOS-delivered MGP, three provided on-site tours and interviews upon request. The data collected from those meetings is provided in the following sections.

2.4 MGP Recycling Plant A[13]

2.4.1 Description of facility

Plant A is a family-owned business that has processed waste and recyclable materials since 1988. The owners began accepting commingled recyclables from New York City Department of Sanitation (DOS) in 1993. The recycling facility, located in the Bronx, was laid out to DEC specifications by a team of consulting engineers in 1988. Approximately 110-140 employees work at the facility. Labor needs fluctuate seasonally; waste flow generally increases during the summer, requiring a larger staff to process the material. Employee turnover is very high. At one point during 2001, the company had 750 employees on record. Plant A operates twenty-four hours a day, Monday – Friday. Saturday hours of operation are 12 AM to 8 PM. Shifts are eight hours long and employ about 40 workers.

2.4.2 Operations

The basic operations of this facility are a) baling of the black-bag commercial waste destined for landfilling; b) sorting and baling the MGP stream; c) baling commercial cardboard; and d) shipping the products by twenty-ton trucks to recyclers or landfills. Plant A receives approximately a) 3000 tons/week commercial "black bag" waste that is baled in 0.8-0.9 ton bales and trucked to landfills; b)1100-1300 tons per week of DOS-collected metal-glass-plastic (MGP) recyclables; and c) 200 tons per week of cardboard from commercial sources. The MGP portion represents 22% of all MGP collected by DOS. Plant A is contracted by the city to process a minimum of 150 tons of MGP per day; actual MGP processed ranges from 250 to 300 tons per day. The DOS contract was expected to be renewed February 2002; the effect of Mayor Bloomberg's recent budget proposal on contract extension and renewals is unknown. For the past

[13] Unless otherwise noted, information reported in Section 2.4 was provided by the plant manager during a tour in January 2002.

seven years, DOS maintained the same rate per ton of recyclable material by postponing contract renewal through contract extensions. The city pays Plant A $62.60 on average per ton[14], approximately $20 more per ton than the private carters pay the plant to receive commercial cardboard and commercial solid waste. This per-ton rate is the highest received by a contracted MGP recycler.

2.4.3 Processing

The DOS commingled material is processed as follows:

1) Tipping: After weighing in, trucks deposit waste on the tipping floor.

Pre-processing:
2) 5-7 workers open blue bags and screen waste for non-recyclable, bulky items.
3) A conveyor belt (Belt 1) transports the waste to an elevated sorting belt (Belt 2).
4) 7 workers remove additional blue bags, plastic bags, and other non-recyclable items. These materials are dropped down a chute for baling and landfilling.

Glass Separation
5) 2 workers positively sort green glass, dropping glass down a chute into a bin.
6) 2 workers positively sort clear glass into a chute for collection.
7) 2 workers positively sort amber and brown glass into a chute for collection.

Screening and Processing of Fines
8) Waste is conveyed over a vibrating screen and a trommel that separate small particles, mostly broken glass, which is then pulverized in a hammer mill.

Separation of Ferrous Metals
9) Material is passed under a magnetic separator which removes metal, primarily tin cans, into a bin for baling.

Separation of Plastic
10) What remains of the stream, plastics and backend residue, is conveyed to Belt 3.
11) 2 workers positively sort colored high density polyethylene (HDPE1) into a bin.
12) 2 workers positively sort natural-colored or clear high density polyethylene (HDPE2) into a bin.
13) 2 workers positively sort polyethylene terephthalate (PET) into a bin.

When markets are strong, workers positively sort additional materials such as PVC and polypropylene into smaller bins.

[14]NYC Office of the Comptroller Bureau of Management Audit 2001

Residue

14) Remaining residue (mostly plastic bags and other non-recyclable plastics) is deposited in a bin for baling. Bales are approximately 3 feet x 5 feet x 6 feet and weigh about 1400 lbs. each. The manager estimates that about 40-50% of the incoming MGP ends up in landfills, either as non-recyclable plastics or as mixed broken glass.

2.4.4 Recovered material

Forty percent of the DOS material is "residue" and is transported to a landfill for disposal. Plant A pays trailer brokers to arrange for removal and disposal of the residue stream. Tractor-trailers transport waste to landfills in Ohio, Pennsylvania, and West Virginia. Residue consists of (a) large non-recyclable items such as strollers, (b) baled non-recyclable plastic (mostly bags and films), and (c) mixed broken glass. Metal goods are hauled to local scrap metal recyclers. All recovered plastic materials are baled and transported to plastic recycling plants, where the plastic melted down and pelleted for use in production of clothing, plastic containers and other goods.

Plant A receives 1100-1300 tons per week of DOS-collected MGP, approximately 24% of all DOS-collected MGP. The products and residues of the sorting facility are shown in Table 2.1.

Table 2.1 Products and residues of MGP stream received at Plant A.

Material	Tons/month	Tons/year	Percent
Clear HDPE	76.8	921.6	1.6%
Color HDPE	76.8	921.6	1.6%
PET	76.8	921.6	1.6%
Other Plastics	158.4	1900.8	3.3%
Aluminum	48	576	1%
Tin	316.8	3801.6	6.6%
Bulk Metal	1200	14,400	25%
Color-sorted Glass	398.4	4780.8	8.3%
Recycled	**2532**	**28,224**	**49%**
Mixed Broken Glass	1200	14,400	25%
Residue	1248	14,976	26%
Total	**4800**	**57,600**	**100.0%**

Approximately 2532 tons is recovered each month. Recovered bulk metal constitutes 25% of the feed. Recovered aluminum is 1% of the MGP and tin cans is 6.6%. Recyclable plastic materials account for another 8.1% of incoming material. Residue

fractions excluding the mixed broken glass stream would range from 20 – 30% residue. If mixed broken glass is included in the residue stream these fractions rise to 47-55% residue.

2.5 MGP Recycling Plant B[15]

2.5.1 Description of facility

Plant B consists of two facilities in close proximity to each other: a paper sorting plant and a MGP sorting plant. Both plants operate twenty-four hours a day, six days per week. The total workforce consists of about forty-five people working ten-hour shifts. All material sorting occurs during the day; a small group works at night only to receive material. The facility was custom designed to fit an existing building by BSE Recycling Works Corporation and the plant manager. Plant management has worked with DOS for twelve years.

2.5.2 Operations

Currently, Plant B has two separate contracts with the city. The paper contract is a twenty-year consisting of four five-year renewable options. The MGP contract is currently in its second extension. As in the case of Plant A, Plant B has received the same tipping fee from the city for seven years. The paper sorting facility receives approximately 48,000 tons per year, i.e. an estimated 8.4 % of the paper stream collected by DOS. In addition, the plant receives 500 tons per month of cardboard from commercial sources, collected and delivered by private carters. The MGP plant receives only 18,000 tons per year, i.e. about 6.7 % of the total NYC MPG stream.

2.5.3 Processing

The DOS commingled MGP is processed as follows:

1) Tipping: After weighing in, trucks dump on the tipping floor.

<u>Pre-processing:</u>

[15] Unless otherwise noted, information reported Section 2.5 was provided by the plant manager during a tour in February 2002.

2) Workers pre-screen material to remove bulk items
3) An inclined conveyor belt transports material to an elevated sorting process.

Separation of Ferrous Metals:
4) A magnetic separator separates bi-metal cans

Separation of Fines:
5) Material is passed through a trommel which separates small pieces of broken glass, plastic, metal and dirt. This stream is called "mixed broken glass"

Separation of Plastic and Aluminum:

6) 8 or 9 pickers employees positively sort plastic and aluminum.

Residue:
7) The remaining material is residue (mostly plastic bags and films) which proceeds to a baler.

2.5.4 Recovered materials

The composition of incoming MGP is fairly consistent, with slightly higher residue during the holiday season. The distribution of material processed in December 2001 is shown in Table 2.2 below.

Table 2.2 Products and residues of MGP stream received at Plant B[16]

Material	Tons/month	Tons/year	Percent
Clear HDPE	24.9	299.4	1.62%
Color HDPE	27.1	325.2	1.76%
PET	24.3	292.0	1.58%
Double Sided Poly	0.6	7.4	0.04%
Aluminum	14.8	177.4	0.96%
Tin	120.1	1441.4	7.80%
Bulk Metal	274.4	3293.1	17.82%
Clear Glass	60.4	724.4	3.92%
Recycled	**546.6**	**6559.2**	**35.5%**
Mixed Broken Glass	798.0	9576.3	51.82%
Residue	195.3	2343.3	12.68%
Total	**1540.0**	**18,480.0**	**100.00%**

Visual inspection of the "mixed broken glass" indicated approximately 50% glass by volume. If the mixed broken glass stream is pulverized, landfill operators accept it as an

[16] From December 2001. Data provided by plant manager.

alternative grading material at a tipping fee $10 less than standard waste tipping fees. Plant B has a pulverizing machine on-site, however it is not operational and low glass prices do not justify the maintenance costs.

2.6 MGP Recycling Plant C[17]

2.6.1 Description of facility

Plant C is operated by a nationwide waste management company. The facility serves as a transfer station for both DOS and commercial waste, as well as processing DOS-collected MGP. Approximately fifty people work at the plant which is operated twenty-four hours a day, six days a week. Most of the separation of MGP occurs during the night shifts. The facility is very large, permitted to process nearly 3000 tons per day of MSW, MGP, and construction and demolition waste. The company has a glass processing machine on site in order to add value to the mixed broken glass stream.

2.6.2 Operations

Plant C has two contracts with NYC DOS to receive 1100 tons per day of MSW and 300 tons per day of commingled MGP. Actual influx of MGP varies from 350 to 600 tons per day with an average of approximately 400 tons per day or 115,937 tons per year, i.e. 42% of the MGP stream collected by DOS.

2.6.3 Processing

The DOS commingled MGP is processed as follows:

Tipping:

1) After weighing in, trucks dump either on an indoor tipping floor or in an open-air tipping area outside of the facility. Front-loaders bring material deposited outside into the facility for processing.

Pre-processing:

2) Workers pre-screen material to remove bulk items
3) An inclined conveyor belt transports material to an elevated sorting process.

[17] Unless otherwise noted, information reported in Section 2.6 was provided by the plant manager during a tour in February 2002.

Separation of Fines:

4) Material is passed through a trommel which separates small pieces of broken glass, plastic, metal and dirt. This material is deposited through a chute into a hauling container adjacent to the building.

Separation of Plastic and Glass:

5) 13 pickers positively sort plastic and glass.

Separation of Ferrous Metals:

6) The conveyor belt carries material by two magnetic separators.

Separation of Aluminum:

7) An eddy current separator separates aluminum material from the stream

Residue:

8) The remaining material is residue (mostly plastic bags and films) which proceeds to a baler.

Glass processing:

1) Mixed broken glass separated from the MGP stream is fed into a hopper which feeds the material into a trommel.
2) Large material passes through the trommel and is visually inspected for recyclable materials.
3) Small pieces of glass and other materials fall through the trommel screen.
4) Magnets separate metal pieces from the small fraction.
5) This material is then pulverized in a hammer mill.
6) Resulting glass sand product is used as an alternative grading material in landfills.

2.6.4 Recovered materials

The composition of MGP material received at Plant C is relatively consistent throughout the year. The average distribution of the materials recovered and residues discarded is shown in Table 2.3 below.

Table 2.3 Products and residues of MGP stream received at Plant C

Material	Tons/month	Tons/year	Percent
Clear HDPE	163.2	1958.4	1.7%
Color HDPE	134.4	1612.8	1.4%
PET	177.6	2131.2	1.81%
Aluminum	114.2	1370.9	1.19%
Tin	912.0	10,944.0	9.5%

Bulk Metal	1344.0	16,128.0	14%
Recycled	**2845.4**	**34,145.3**	**29.6%**
Mixed Broken Glass	3801.6	45,619.2	39.3%
Residue	3014.4	36,172.8	31.1%
Total	**9661.4**	**115,937.3**	**100.00%**

Recovered materials such as plastics are baled and transported by trucks to recycling facilities. The mixed broken glass stream is processed in the on-site glass pulverizing process described in the previous section. The residue is baled. These bales and pulverized glass are hauled to out-of-state landfills. However, the pulverized glass is used as an alternative grading material.

2.7 Evaluation of the New York City Recycling Program

Since its inception, the curbside recycling efforts of the Department of Sanitation's have been the subject of intense scrutiny. Although the size and density of New York represents an enormous and unique waste management challenge, the City has successfully developed a collection infrastructure and awareness of recycling in all of its residential communities through innovative public education efforts and impressive research initiatives within the Department's Bureau of Waste Prevention, Reuse, and Recycling (BWPRR). Unfortunately, much of the scrutiny addresses issues beyond the Department's direct jurisdiction in the separation facilities receiving DOS-collected materials. This study, like others before it, confirms that while paper recyclers consistently recover over 90% of DOS-collected material, as little as 30% of the MGP collected is actually recovered and sold for reprocessing. The following section reviews waste management strategies in Phoenix, Arizona and Chicago, Illinois to evaluate how other U. S. cities are collecting and processing recyclable material and to determine whether application of these programs could improve the recovery of recyclables in New York City.

3. Phoenix, Arizona: Commingled collection and processing

3.1 Background

A single-stream materials recovery facility (MRF) is a facility that separates recyclable commodities from one stream of commingled materials. Construction and

operation of such a facility is one way to decrease New York City's collection costs and possibly increase the percent of recyclable materials recovered from the waste stream. Single-stream MRFs have been in use since the late 1980's,[18] with facilities currently operating in Phoenix, AZ; Los Angeles, CA; Seattle, WA; and Palm Beach County, FL, among other locations. Municipal or county governments identify materials to be separated by residents in their home, including paper, metal, plastics and glass. Recyclable material is collected in one stream curbside, separate from the collection of non-recyclable MSW. The relatively lower cost of collecting one stream of recyclable material as opposed to separate collection of two or more source-separated streams appeals to many local governments interested in diverting material from landfills. Critics of single-stream MRFs argue that commingling paper and container streams contaminates the recyclable material; however over the past decade, improved separation technology has enabled operators to extract high-quality, salable commodities from fully commingled recyclable waste.

3.2 The 27th Avenue Materials Recovery Facility in Phoenix, AZ

The flow chart of Figure 3.1 shows the separation mechanisms utilized in one of the single-stream MRFs in operation in Phoenix, AZ. Known as the 27th Avenue MRF, the facility was designed by the McGuire Group with installation assistance from Resource Recovery Technologies (RRT) of Melville, New York. Construction of the building cost the city two and a half million dollars in 1998; the separation equipment cost an additional five and a half million dollars.[19] It has a capacity of 320 tons per day and represents recovery technology that is common to recently-constructed single-stream MRFs around the nation.[18] The capital cost of this MRF amounts to $80 per annual ton capacity, or The facility is one of two MRFs currently processing Phoenix recyclables. A third facility is scheduled for completion in 2005 to handle the anticipated increase in recyclable material. In 2001, the City of Phoenix Public Works Department collected 106,970 tons of recyclable material from 326,855 single and multi-family households. From this material, 82,235 tons was recovered.[20]

[18] Biddle 1998
[19] Phoenix Public Works Department 1998
[20] Arizona Department of Environmental Quality 2001

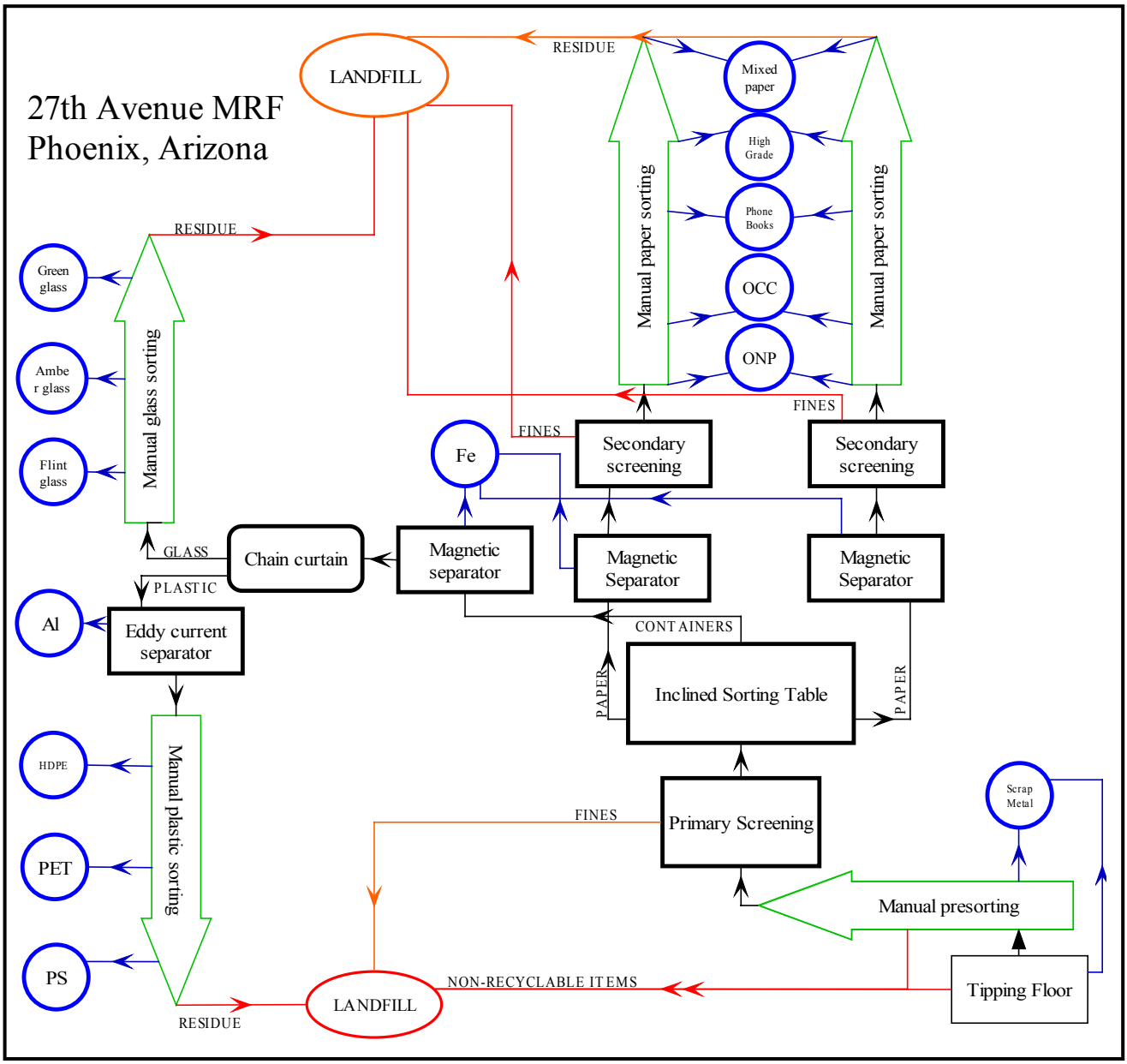


Figure 3.1. Schematic of single-stream materials recovery facility in Phoenix, AZ.

As shown in Figure 3.1, the sorting of waste starts on the tipping floor where bulky, non-recyclable items and scrap metal are removed and the remainder of the stream is loaded onto an inclined conveyor belt by means of grapples and front-loaders. Workers then further screen the conveyed material for bulky items unsuitable for the automated separation equipment. The first automated device is the primary screening machine which sifts out fine materials such as dirt and broken glass using vibrating horizontal screens.

The oversize material passes over the screens and is deposited at the top of an inclined sorting table. An inclined sorting table consists of inclined conveyor belts that rotate perpendicular to the direction of the incline and away from where incoming material is deposited. When the commingled stream is deposited on the inclined surface, the paper material follows the direction of the conveyor belts and moves across the incline and falls off the sides of the table onto conveyor belts. The metal, glass, and plastic containers roll down the surface of the incline perpendicular to the movement of the belts, and fall onto a separate conveyor belt lying underneath and across the base of the sorting table. These containers are then transported to a magnetic separator. After the ferrous materials have been separated, a rotating chain curtain separates glass containers from plastic containers. As the stream proceeds along an inclined conveyor belt, the heavy glass containers roll through the rotating curtain of heavy chain while the lighter plastic and aluminum containers continue with the movement of the conveyor belt. Manual separation is then used to sort the glass stream into flint, amber, and green glass. The lighter stream is sent through an eddy current separator to recover aluminum and the remaining plastics are then sorted manually.

The paper stream resulting from the inclined sorting table is also subjected to magnetic separation to recover ferrous materials. Workers then manually sort the remaining material into newspaper, telephone books, cardboard, mixed paper, and high-grade paper streams.

3.3 Recovery of recyclable material

Using the technology described above, the city of Phoenix diverted 82,235, i.e. 76.9% of the curbside commingled recyclables stream. This material represents 14.3% of the total MSW managed in 2001, i.e. 573,834 tons. Table 3.1 shows the amount of targeted material available in the total city-managed waste stream and the capture rate of each material.

Table 3.1. Composition and recovery of Phoenix MSW, fiscal year 2001

Material	Total MSW tons	% of MSW[21]	Collected recyclables (tons)	Recovered recyclables (tons)	% Captured from MSW
Paper	218,631	38.1	n/a	70906	32.4
Metal	44,759	7.8	n/a	3407	7.6
Glass	31,561	5.5	n/a	3198	10.1
Plastic	60,253	10.5	n/a	4725	7.8
Non-targeted/ Other	218,631	38.1	n/a		
Total	**573,834[22]**	**100**	**106,970[20]**	**82,235.70[23]**	
			% of MSW collected	**% Recovery from collected recyclables**	**% Recovery from total MSW**
			18.6	**76.9**	**14.3**

3.4 Application of commingled collection and processing to New York City

In order to evaluate the potential for single stream collection and processing of recyclables in New York City, it is necessary to adjust for the unique waste management and composition in the city. A waste characterization study performed by NYCDOS in 1990 showed the City's MSW has slightly lower fractions of paper and yard waste and a higher fraction of food waste than MSW in the rest of the country. Because the Phoenix Public Works Department manages fewer types of waste than NYC DOS, it is also necessary to include only DOS curbside and containerized MSW and recyclables when calculating the total amount of MSW managed NYC. Some reports[19,24] of the amount of waste recycled by NYCDOS include a large "other" fraction that combines a variety of public pick-up and drop off programs. Although Phoenix runs a similar array of special waste collection programs, these waste streams are not included in this comparison because any changes in collection and processing of New York City residential recyclables will not likely affect those waste streams.

Table 3.2 shows the total amount of MSW and recyclables managed by NYC in 1999. The rest of Table 3.2 is calculated by assuming that a single-stream of recyclables is collected and processed in a new single-stream MRF. Although the amount of material

[21] USEPA 1998
[22] NYC DOS 2001
[23] ADEQ 2001

collected could potentially increase given the simplicity of household separation of commingled recyclables, this study did not investigate or prove such a trend. Therefore, the percent of MSW diverted from the waste stream in the commingled scenario is assumed to be the same amount as diverted under the current system. The rate captured by the MRF and the overall rate of recovery from MSW, however, are calculated and compared to current rates.

Table 3.2 Potential of single-stream collection for increased recovery of recyclables in NYC

Material	NYC total MSW (tons)	% of MSW[25]	Collected recyclables (tons)	Phoenix recovery rate (%)	NYC recovered recyclables (tons)	Actual recovery 1999 (tons)
Paper	1,443,362	33	n/a	32.4	468,112	357,733
Metal	218,691	5	n/a	7.6	16,645	64,801
Glass	262,430	6	n/a	10.1	26,588	2,809
Plastic	437,383	10	n/a	7.8	34,299	15,880
Non-targeted/Other	2,011,959	46	n/a			
TOTAL	**4,373,825[26]**	**100%**	**671,535[6]**		**545,644**	**441,223[6]**
				% of MSW collected	**% Recovery from collected recyclables**	**% Recovery from total MSW**
		Commingled System		**15.4**	**81.3**	**12.5**
		Current System (1999)		**15.4**	**65.7**	**10.1**

The calculated recovery tonnages given in Table 3.2 represent the recoveries expected if a commingled recycling program such as that implemented in Phoenix were applied to the recyclable material available in the New York City waste stream. The discrepancy between the 76.2% MRF efficiency reported in Phoenix and the 81.3% single-stream recovery expected in New York City can be attributed to the lower amounts of available recyclable material in the New York City waste stream. The calculated recovered tonnage reveals an increase of about 95,000 tons of material recycled using the single collection and indicated MRF system.

Also worth noting is the low percentage of metals recovered from the Phoenix MRF; unlike the Department of Sanitation, the Phoenix Public Works Department does

[24] NYC Office of the Comptroller Bureau of Management Audit 2001
[25] SCS Engineers 1991
[26] NYC Office of the Comptroller Bureau of Management Audit 2001

not accept white goods as part of its curbside recycling program. Because Figure 3.1 shows that the Department of Sanitation could recover curbside-collected white goods from the tipping floor of a single-stream MRF, it is likely that a commingled recycling program would allow for continued collection and recovery of white goods. This inclusion would yield a percent recovery of available metal that will be higher than seen at Phoenix.

There is much debate currently in the waste management community as to what material should be included in diversion rate calculations. NYCDOS considers all material delivered to contracted recyclers in the city as diverted from landfill disposal. For the purposes of this study, three rates are calculated: (1) the rate of material diverted from the MSW stream by households and collected by NYCDOS, (2) the rate of material captured by recycling facilities, and (3) the percentage of the entire city-managed MSW stream that is recovered and recycled. The first rate is what the NYC Department of Sanitation considers the "diversion rate."

3.5 Economics of a single-stream materials recovery facility for NYC

Table 3.2 indicates that processing a combined paper and MGP stream in New York City would recover more material for sale than is actually recycled in the current program. Based in part on increased revenues from recyclable materials, Table 3.3 outlines the annual costs of a 150 ton-per-hour (876,000 per year) MRF adapted from a study by Dubanowitz.[24]

Table 3.3 Estimated costs and revenues for a 876,000 TPY MRF[27]

Cost Component	Annual Cost (2001$)
Site lease costs	2,236,680
Annualized capital charges	7,134,050
Operation & maintenance	5,422,750
Collection Costs	96,628,500
Residues Tipping Fee	13,010,001
Revenue from Recyclables	-28,109,196
Total Costs	**96,322,785**
Capital Cost per Annual Ton	**$69/ton**
Total Cost per Annual Ton	**$110/ton**

[27] Dubanowitz 2000

Residue tipping fees in Table 3.3 were calculated using an average tipping fee of $63.82 per ton[28] and include disposal of mixed broken glass as an alternative grading material at a discounted rate of $53.82 per ton. Revenues from recyclables are based on average 2001 prices.[29] [30] Capital cost per annual ton was calculated based on a total capital cost of $60.7 million also adapted from Dubanowitz. The annual capital costs are obtained by amortization of the initial capital investment over 20 years at a ten percent interest rate. The capital cost per annual ton is calculated by dividing the initial capital investment by the annual capacity of the facility. The $69 per annual ton is less than the $80 dollars per annual ton calculated for the Phoenix MRF, indicating the economies of scale of a larger facility. Dubanowitz cautions that these costs "should be used only as a guide for the costs of a MRF," yet there is still a large margin between the $110/ton indicated here and the costs mentioned in Mayor Bloomberg's budget proposal. Bloomberg cited costs of $230/ton of MGP and $87/ton of paper.[31] The average of those numbers, weighted by the relative total tonnages collected in 1999, results in $146/ton. Although the values shown in Table 3.3 are largely dependent on the amortization period used and on rising landfill disposal costs, the wide margin between the two costs indicate that under the commingled scenario the city would benefit not only from increased material recovery but from lower costs as well.

A city-owned MRF would also allow the city to more closely monitor the actual recovery and sale of city-collected recyclable material. Sanitation Commissioner Kevin Farrell mentioned this point in the May 2001 response to City Comptroller Alan Hevesi's audit of the recycling program: "If the city owned and operated its own MRF, [it] would have full accounting of all recyclable materials handled by those facilities."[6] This access would not only prove valuable as a measurement of the success of the program, but closer monitoring would also allow the city to more accurately identify problematic materials and districts and tailor its public education more effectively. Another benefit of the single-stream collection and MRF scenario for NYC recyclables is that the city would not have to re-educate the public on recyclable materials; education efforts would need only

[28] NYC IBO 2001
[29] Recycling Manager 2001
[30] Recyclers World 2002
[31] Bloomberg 2002

to explain the relatively easy concept of single-stream collection. New York citizens would most likely appreciate the ease of separating material into only one stream.

4. Chicago: Co-collection of source-separated recyclables and MSW

4.1 Background

Co-collection is a relatively new strategy for reducing collection costs associated with curbside recycling programs. In such a program, residents source-separate multiple streams of recyclable material into separate bags. These bags are distinctive in color from standard garbage bags. Waste and recyclable materials are then set out at the curb together and co-collected in one standard waste hauling vehicle. All material is then tipped at a sorting center where bags are separated into MSW and recyclable streams and processed to recover recyclable material from both recyclables and MSW. The City of Chicago operates the only large-scale co-collection program in the U. S. Residents are instructed to separate material into four streams: recyclable containers, recyclable paper, yard waste, and MSW. Transparent blue bags are sold in grocery stores, and are used for all recyclable streams.

4.2 Chicago Materials Recovery Facilities

The City of Chicago Department of the Environment launched the Blue Bag Recycling program in 1995. Fifty-four million dollars in public bonds financed the construction of four MRFs designed to handle a large stream of co-collected MSW and recyclable paper, containers, and yard waste.[32] Each facility has a capacity of 1200 tons per day.[33] Waste Management is contracted until 2003 to operate the four facilities. The city pays Waste Management a processing fee of $21.89 for each ton tipped at the MRFs. An additional $44.14 is paid for each ton that is landfilled. However, the contract stipulates that the city will only pay this disposal fee for up to 75% of the total tons

[32] White 2001
[33] Egosi 2002

delivered.[34] Thus if Waste Management fails to recover 25% of the material, the company must defray the additional landfilling costs on its own.

The Department of Streets and Sanitation collects waste from low-density housing only, but collection of recyclables from high-density housing, commercial, construction, and industrial waste is mandated by the city. Collection and recycling of this material is performed by private companies at different facilities. In 2001, the city collected and delivered 1,237,046 tons of waste to the MRFs.[28] An estimated additional 1,992,799 tons were collected by private companies.[35]

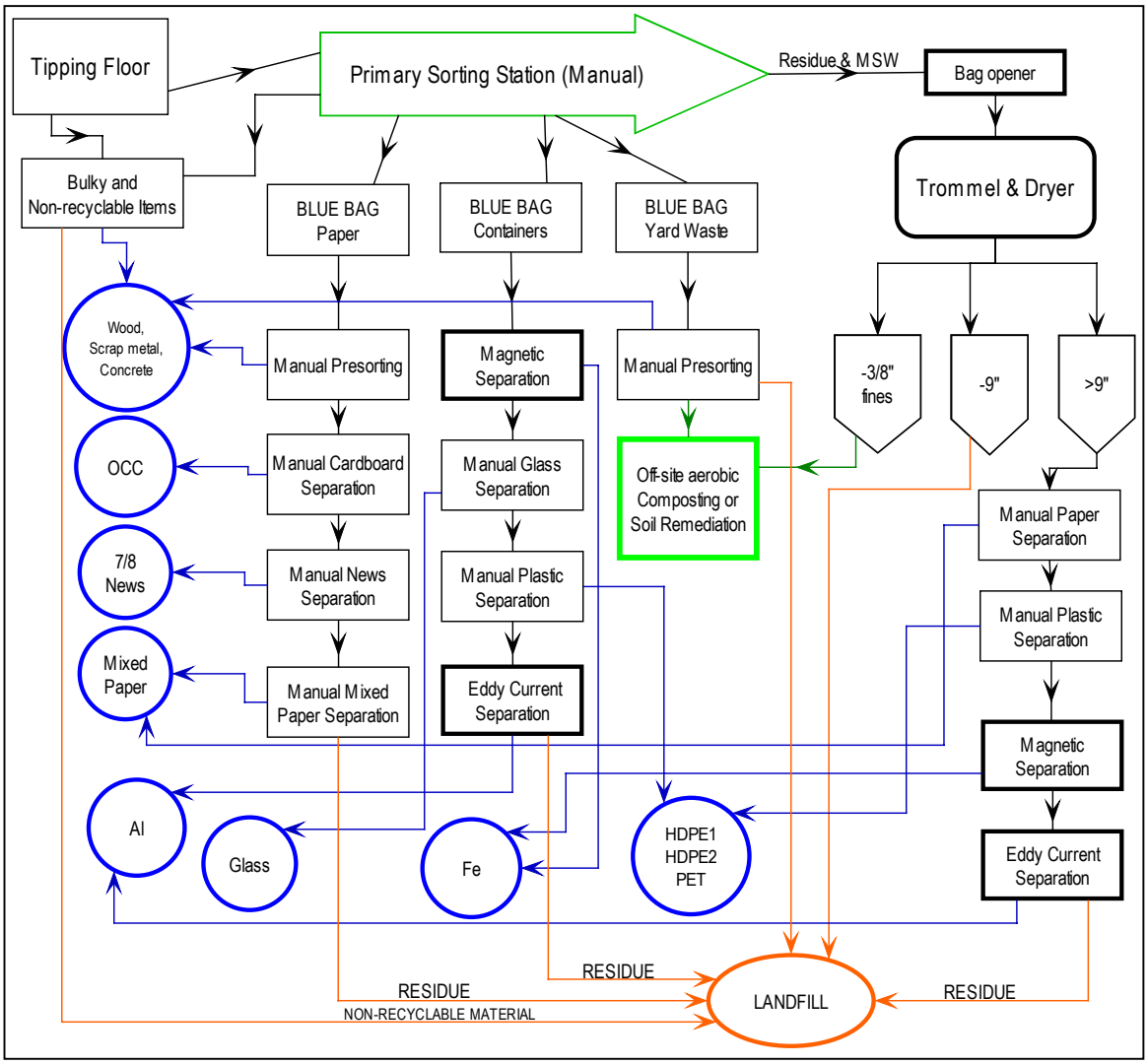


Figure 4.1 Schematic of Chicago materials recovery facilities

[34] Keane 2002
[35] NYC DOS 2001

Figure 4.1 shows the separation processes used to recover recyclable materials from Chicago's waste stream. Material tipped on the tipping floor is screened for bulky and non-recycable items, and then loaded by front-loaders and grapples onto a conveyor belt. The first primary sorting is manual: Workers positively sort blue bags into paper, containers and yard waste streams based on what is visible inside the bags. The MSW continues through the primary sorting station over to a bag opener. Material is then screened and dried in a trommel. The undersize material, less than 3/8 of an inch, is separated for land application in soil remediation projects. The mid-sized stream, less than nine-inches, is landfilled, and the greater than nine-inch stream is subjected to an Enhanced Recovery System designed by Resource Recovery Technologies (RRT). This section of the MRF was added in 1998 and is designed to increase diversion rates by recovering more material from municipal solid waste. Paper and plastic material is removed manually and metals are recovered through magnetic and eddy current separation. The remaining material is considered "residue" and is landfilled.

The blue bag streams created at the primary sorting station go through three different processes. The paper stream is sorted in an entirely manual process similar to the separation occurring at New York paper recyclers. Workers positively sort newsprint, old corrugated cardboard, and mixed paper. The container stream, analogous to New York's MGP stream, passes through a magnetic separator. Glass and plastic is manually separated, and aluminum is recovered using an eddy current separator. The residue streams from both the paper and container lines are landfilled. Yard waste is presorted for non-compostable material and is then hauled to an off-site aerobic composting facility.

4.3 Recovery of recyclable material

In addition to paper, metal, glass, and plastic, Chicago recovers concrete, wood, and yard waste through the city MRFs. The purpose of this study was to suggest improvements for increasing the recovery of material targeted currently under the New York City curbside recycling program. For this reason and to ensure an accurate comparison to New York's current recovery, the yard waste, concrete, and wood fractions are not included in the city of Chicago's recovery rates, or in the projected co-collection recovery rates for New York City.

Table 4.1. Composition and recovery of Chicago recyclables 2001 (U.S. Composition Data.)

Material	Total MSW (tons)	% of MSW[36]	Collected recyclables (tons)	Recovered recyclables (tons)	% Captured from MSW
Paper	471,315	38.1	n/a	59,776	12.7%
Metal	96,490	7.8	n/a	31,504	32.7%
Glass	68,038	5.5	n/a	2,929	4.3%
Plastic	129,890	10.5	n/a	941	0.7%
Non-targeted/ Other	218,631	38.1	n/a	(193,626)	
Total	**1,237,046[37]**	**100**	**1,237,046**	**95,150[38]**	
			% of MSW Diverted	**% Recovery from collected recyclables**	**% Recovery from total MSW**
			100%	**7.69 (23.3)**	**7.69 (23.3)**

Table 4.1 uses waste composition data for the United States to determine how successful the Chicago co-collection system is in recovering paper and MGP from the residential waste stream. The percentage of material diverted from the residential waste stream for processing is shown as 100% because all city-managed waste in Chicago is sent to a MRF. Because all MSW is sent to the MRF, the percentage of material recovered from the MRF and the percentage of material recovered from city-managed MSW are equal. Although, these values are not useful in evaluating the overall value of a co-collection system, these calculations will be compared to current New York City recoveries to determine if a co-collection system could improve metal, glass, and plastic recovery in the city.

To address suspected discrepancies between typical U. S. MSW and residential waste in New York City, the Department of Sanitation had a waste composition study performed in the early 1990s. Chicago has not published city-specific waste characterization information, but it is possible that Chicago MSW is more similar to New York MSW due to its large population and high density of households relative to the rest of the United States. As shown in Table 4.2, applying New York waste composition data to the Chicago MSW decreases the amount of paper and metal available in the waste stream, and therefore the computed recovery rates for metal and paper increase.

[36] USEPA 1998
[37] Keane 2002

Table 4.2. Comparison of metal and paper recovery in Chicago using U.S. and New York waste composition data

Material	Total MSW (tons)	% of MSW[39]	Recovered recyclables (tons)	**% Captured from MSW (NYC Data)**	**% Captured from MSW (U.S. Data)**
Paper	**408,225**	**33**	**59,776**	**14.64%**	**12.7%**
Metal	**61,852**	**5**	**31,504**	**50.93%**	**32.7%**
Glass	74,223	6	2,929	3.95%	4.3%
Plastic	123,705	10	941	0.76%	0.7%
Non-targeted/ Other	218,631	46	(193,626)		
Total	1,237,046[40]	100	95,150[32]		

4.4 Application of co-collection to New York City

Using Chicago recovery rates calculated on the basis of New York City waste (Table 4.2), Table 4.3 applies Chicago's recovery rates to the materials targeted in New York's current recycling program. As is the case in Chicago, it is assumed that all of DOS-collected MSW would be delivered to MRFs for processing.

Table 4.3 Potential of co-collection for increased recyclables in NYC

Material	**Tons available**	**% of MSW[41]**	**Collected recyclables (tons)**	**Chicago recovery rate (%)**	**Recovered recyclables (tons)**	**Recovered recyclables NYC 1999 (tons)**
Paper	1,443,362	33	n/a	14.6%	211,349	357,733
Metal	218,691	5	n/a	50.9%	111,389	64,801
Glass	262,430	6	n/a	3.9%	10,356	2,809
Plastic	437,383	10	n/a	0.8%	3,326	15,880
Non-targeted/Other	2,011,959	46	n/a			
Total	**4,373,825[42]**	**100%**	**4,373,825**	**7.69**	**336,421**	**441,223[6]**
			% of MSW diverted	**% Recovery from collected recyclables**		**% Recovery from total MSW**
Co-collection			**100**	**7.7**		**7.7**
Current System (1999)			**15.4**	**65.7**		**10.1**

[38] City of Chicago Department of the Environment 2001
[39] USEPA 1998
[40] Keane 2002
[41] SCS Engineers 1991
[42] NYC Office of the Comptroller Bureau of Management Audit 2001

Table 4.3 shows that a co-collection system would not increase the recovery of paper and MGP from New York City MSW. Although Chicago has published diversion rates as high as 47.9%, these figures include privately-collected and processed high-density housing, commercial, construction and industrial waste. These waste streams are not processed in the Chicago MRFs designed to handle co-collection of MSW and recyclable material. Therefore, including these recoveries in an evaluation of the co-collection system would imply successful recoveries that in reality are attributed to different collection and processing.

The waste composition study cited in Tables 4.2 and 4.3 shows that approximately 33.4% of New York City MSW is recyclable paper, metal, glass and plastic. One of the theories behind co-collection is that by processing the entire waste stream in a MRF, all of the recyclable material available in the waste stream has an opportunity to be separated and recycled. In other words, waste managers have a chance to recover recyclable material that is incorrectly disposed of by residents, thereby increasing overall recovery from the waste stream. The obvious problem with this scenario is material that would have been protected in a source-separated program is contaminated and unrecyclable, negating the incremental improvement in recovery due to processing the entire waste stream. Chicago hoped to address this contamination problem by mandating source-separation to shield recyclable material from contaminating "black bag" waste during co-collection. Table 4.3, however, indicates that despite source-separation, the Chicago recycling program renders too much recyclable material unrecoverable due to dispersion and contamination.

5. Conclusions

On-site surveys of the current metal, glass and plastic recycling facilities of New York City reveal a situation unlikely to improve. Recyclers are plagued by a variety of obstacles to increased recovery including overcrowded facilities and low market value of the recovered materials. Also, current market economics and the enormous overhead costs of such recycling operations make increased recovery through automation and expansion very difficult. The city needs to commit to a more easily managed system that

can increase material recovery over time by adopting new technologies and directly monitoring recovery and sale of material

In the face of an impending budget crisis, the New York City Department of Sanitation must also justify the enormous cost of collecting recyclable materials. According to Mayor Bloomberg, the current average MGP recovery rate of 40% does not warrant collection costs of over $100 per ton. On the other hand, market research by NYC DOS indicates that New York residents strongly support recycling.[43] While the Mayor's proposal to suspend the MGP program may be necessary to address both the budget gap and the inefficiencies of the program, it is in the best interest of the city and its residents to take the opportunity to closely examine the options available for curbside citywide recycling.

Other cities publishing diversion rates approaching fifty percent make it easy to criticize the Department of Sanitation for failing to achieve acceptable recovery rates, but these figures include materials recycled outside of curbside recycling programs through drop-off and special collection initiatives. In an attempt to determine if higher material recovery from curbside recycling could be achieved in New York City, this report examined two recycling programs in operation in Phoenix and Chicago. The commingled recyclables system in Phoenix is representative of the most common type of curbside recycling program implemented in U. S. urban areas. Chicago, however, is unique in its co-collection strategy. By reviewing these two programs and applying both Phoenix and Chicago recovery rates for the materials targeted in New York's curbside recycling program, it is apparent that investment in a city-owned single stream MRF would increase recovery of recyclable material. Table 5.1 shows that implementation of a single-stream collection and processing system would increase the citywide diversion rate from 10.1% to 12.5%. If the City continues its curbside collection of white goods, the recovery of metals from the waste stream would increase, boosting the overall diversion rate to 13.6%. This increased diversion rate represents an additional 152,322 tons of material diverted from export and landfill disposal.

[43] NYC DOS 1999

Table 5.1 Comparison of recovery rates from current, commingled, and co-collection recycling programs

		Current NYC Program		Single-stream scenario		Co-collection scenario	
Material	**Available in MSW (tons)**	**Tons Recovered**	**Recovery Rate**	**Tons Recovered**	**Recovery Rate**	**Tons Recovered**	**Recovery Rate**
Paper	1,443,362	357,988	24.8%	468,112	32.4%	211,349	14.6%
Metal	218,691	64,801	29.6%	16,645	7.6%	111,389	50.9%
Glass	262,430	2,809	1.1%	26,588	10.1%	10,356	3.9%
Plastic	437,383	15,880	3.6%	34,299	7.8%	3,326	0.8%
Other	2,011,960						
Total	**4,373,825**	**441,478**		**545,644**		**336,421**	
Diversion		**10.1%**		**12.5%**		**7.7%**	

Institutionalizing the New York City recycling program by investing in a city-owned materials recovery facility would improve recovery, reduce overall program costs, and facilitate better management. Although current recovery rates by NYC DOS are in fact higher that the co-collection program implemented in Chicago, this study shows that implementation of a commingled recyclables program like the program in Phoenix would increase recovery of recyclable materials in the waste stream.

Commingled collection of recyclable material will reduce the number of required collections from three to two. Because collection represents the largest fraction of recycling costs, this should have a significant impact on overall program costs. Table 3.3 indicates that the city could construct a single-stream materials recovery facility, collect and process recyclable materials for $110 dollars per ton. This represents a one hundred twenty dollar decrease from MGP costs quoted by Mayor Bloomberg and ninety dollar decrease from the recycling program costs as calculated by Dubanowitz in 2000.

One concern of shifting separation of recyclables from private contracted-recyclers to a city-owned operation is the effect such a move would have on the private recycling industry in New York City. Data collected from interview and tours indicates that DOS-delivered material represents anywhere from 50 to 89% of total material

processed at contracted paper recycling facilities. DOS-delivered materials constitute 25-50% of total inflow at MGP recycling facilities city-contracted recyclers. The city's contract with Visy Paper would also be affected. However, the city could send paper separated from a stream of commingled recyclables by a city-owned MRF to Visy Paper instead of unprocessed curbside collected paper.

New York's Department of Sanitation explored the possibility of building city-owned Materials Recovery Facilities (MRFs) in the early 1990's, but the plans were halted by opposition from private recyclers as well as by lack of political and public support. The overwhelmingly negative reaction to Mayor Bloomberg's proposed suspension of metal, glass, and plastic (MGP) recycling suggests that perhaps now there is enough motivation and public support to address and improve the inefficiencies of the current program.

References

Arizona Department of Environmental Quality. *Annual Waste Reduction and Recycling Questionnaire*, 2001. Completed by Carl Smith of the City of Phoenix Public Works Department.

Biddle, David. "MRF Designs Around Single Stream Recycling." *BioCycle*: August 1998.

Biddle, David. "Comparing Recycling Programs in Major U.S. Cities." *BioCycle*: September 2001.

Bloomberg, Michael R. "Mayor Michael R. Bloomberg's Presentation of Preliminary Budget for Fiscal 2003." New York City Office of Management and Budget: February 13, 2002. http://nyc.gov/html/om/html/2002a/budget_2003.html

City of Chicago Department of Environment. "Blue Bag Recycling Program Results." 2001. http://www.ci.chi.il.us/environment/BlueBag/Results.html.

City of New York Independent Budget Office. *Overview of the Waste Stream Managed by the NYC Department of Sanitation*: February 2001.

City of New York Independent Budget Office. "Closing Fresh Kills Means Mounting Costs to dispose of New York City's Garbage." *Inside the Budget*: No. 77, February 5, 2001.

City of New York Office of the Comptroller: Bureau of Management Audit. *Audit of the New York City Department of Sanitation's Recycling Program*. June 29, 2001

City of Phoenix Public Works Department. "This is the MRF Where Phoenix Recycles." 1998.

Dubanowitz, Alexander J. *Design of a Materials Recovery Facility for Processing the Recyclable Materials of New York City Municipal Solid Waste*. Columbia University Earth Engineering Center: May 2000.

Egosi, Nathiel. Resource Recovery Technologies. E-mail correspondence. April 2002.

Keane, Erin. City of Chicago Department of Environment. Telephone conversation. April 2002.

New York City Department of Sanitation: Bureau of Waste Prevention, Reuse and Recycling. *New York City Recycling in Context: A Comprehensive Analysis of Recycling in Major U.S. Cities*. August 2001.

New York City Department of Sanitation: Bureau of Waste Prevention, Reuse and Recycling. *Recycling: What do New Yorkers Think? Five Years of Market Research*. Fall 1999.

New York City Department of Sanitation: Bureau of Waste Prevention, Reuse and Recycling. "What happens to my recyclables?" June 1995. http://www.nyc.gov/html/dos/html/bw_what/index.html.

Recyclers World. "RecycleNet Waste Paper Index – Online Market Prices." May 15, 2002. http://www.recycle.net/price/paper.html.

Recycling Manager. "Recycling Manager Archives." American Metal Market, LLC: 2001. http://www.amm.com/recman/recprmnu.htm.

SCS Engineers. *New York City Waste Composition Study*. 1991.

United States Environmental Protection Agency Office of Solid Waste and Emergence Response. *Municipal Waste Generations, Recycling, and Disposal in the U.S.: Facts and Figures for 1998*. EPA530-F-00-024. April 2000.

White, Kathleen M. "Recycling in Chicago: A Mixed Bag." *Waste Age*: March 2001.