City of Minneapolis
Dual Sort/Single Sort Collection Study
May 10, 2012

416 Longshore Dr. | Ann Arbor, MI 48105 | 734.996.1361 p | 734.996.5595 f | www.recycle.com

Report

Minneapolis
City of Lakes

SEH

Resource Recycling Systems
Sustainable Systems for a Waste-Free Future

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EXECUTIVE SUMMARY AND KEY POINTS

The State of Minnesota has established new recovery goals for Hennepin County, which includes 45% recycling rate by 2015 and 47% by 2020. Hennepin County has established a recycling goal of 35% for the City of Minneapolis. The City of Minneapolis contracted a study and assessment of collection options and the impact on the value of the marketable materials, to assist in determining its next steps.

The City operates a bi-weekly at-the-curb, multi-sort collection system, which requires residents to place all items in separate paper bags in their recycling bin. Although the community accepts and supports recycling, for more than 10 years the city has seen a stagnant recycling rate, and in some years, the rate has declined. The City has a fairly good participation rate for the recycling program, yet compared to other cities in the region and the nation; the amount of material recycled by residents is far below the regional and national average.

Minneapolis conducted two pilot programs, testing the effectiveness of dual-sort and single-sort collection. Both pilot programs incorporated recycling carts and collecting on the bi-weekly schedule. The results from these pilot programs show a significant increase in number of stops that can be served by a single route and the quantity of recyclables collected per household.

Key Points from Recycling Program Study

The study findings, summarized below, are based on information collected from the city's pilot programs and from the experiences of other cities, and from focus group meetings held with current Solid Waste and Recycling customers. The project evaluated single-sort and dual-sort collection for both weekly and biweekly collection.

Recovery

1. A single-sort system is projected to increase materials quantity recovered by 60% and the Minneapolis recycling rate increases from 18.1% to 32% (based on case studies such as Ann Arbor and Portland).
2. A dual-sort system is projected to increase materials quantity recovered by 36% and the Minneapolis recycling rate increases from 18.1% to 25% (based on case studies such as Ann Arbor and Portland).

Processing

1. The majority of local recycling centers - Material Recovery Facilities (MRF's) - are well equipped to handle single sort collection.
2. Preliminary research indicates no difference in market revenues – single vs. dual in local MRF's.

Operations and Operational Costs

1. Collection time for single-sort is less than dual-sort and there is no need to come off route when one compartment fills before the other.
2. A single-sort recycling system preserves space for a possible third cart for comingled yard waste and organics.
3. A semi-automated rear load truck (such as currently used for garbage collection), with 2 staff per truck, best serves alley-based collections. This is the same system that is currently used for garbage collection.
4. Single-sort collection allows for utilization of a similar truck fleet to current rear load packers, resulting in a more cost-effective fleet than adding a completely new type of vehicle for recycling collection.

Capital Costs

1. Dual-sort collection requires an additional truck cost of $28,000 more than single sort truck due to split body packers.
2. Cart cost for single sort (1 per unit @$65) is estimated at $6,800,000.
   Truck Cost (8 trucks) for a bi-weekly single sort collection program is $1,976,000.
3. Cart cost for dual sort (2 per unit @$50) is estimated at $10,500,000.
   Truck Cost (9 trucks) for a bi-weekly, dual sort collection program is $2,475,000.

Overall Program Costs

The Net Recycling Costs are the lowest for the Single Sort Semi Automated Bi-weekly collection program by approximately 20% below current net cost while achieving a 32% recycling rate. The Dual Sort Bi-weekly program has a net cost of approximately 65% higher then the current multi-sort program and achieves a 25% recovery rate. A ten percent increase in the quantity of material collected in the single sort program achieves a 35% recycling rate with a net cost that is 40% lower then the current program. A ten percent increase in the quantity of material collected in the dual sort program achieves a 28.5% recycling rate with a net cost that is 40% higher then the current program.

Single-sort collection and processing also allow consideration of transferring recyclables from milt-family locations should Minneapolis be interested in offering recycling services in currently under-served areas. Single sort collection programs are more compatible with the development of a yard waste and organics collection program that would require another cart.

Although dual-sort recycling remains technically viable, when you consider that the market trend is toward single-sort processing and that placing recyclables all in one container, which is the most convenient to most residents, it is clear that Minneapolis should consider switching to single-sort collection.

It is further recommended that the City conduct a more detailed evaluation of the program and investment requirements associated with such a conversion to single sort collection and processing by issuing a Request for Proposal (RFP) to determine the actual collection and processing costs. This evaluation would include equipment options and costs, processing and marketing arrangements, route requirements, and program investments and savings.

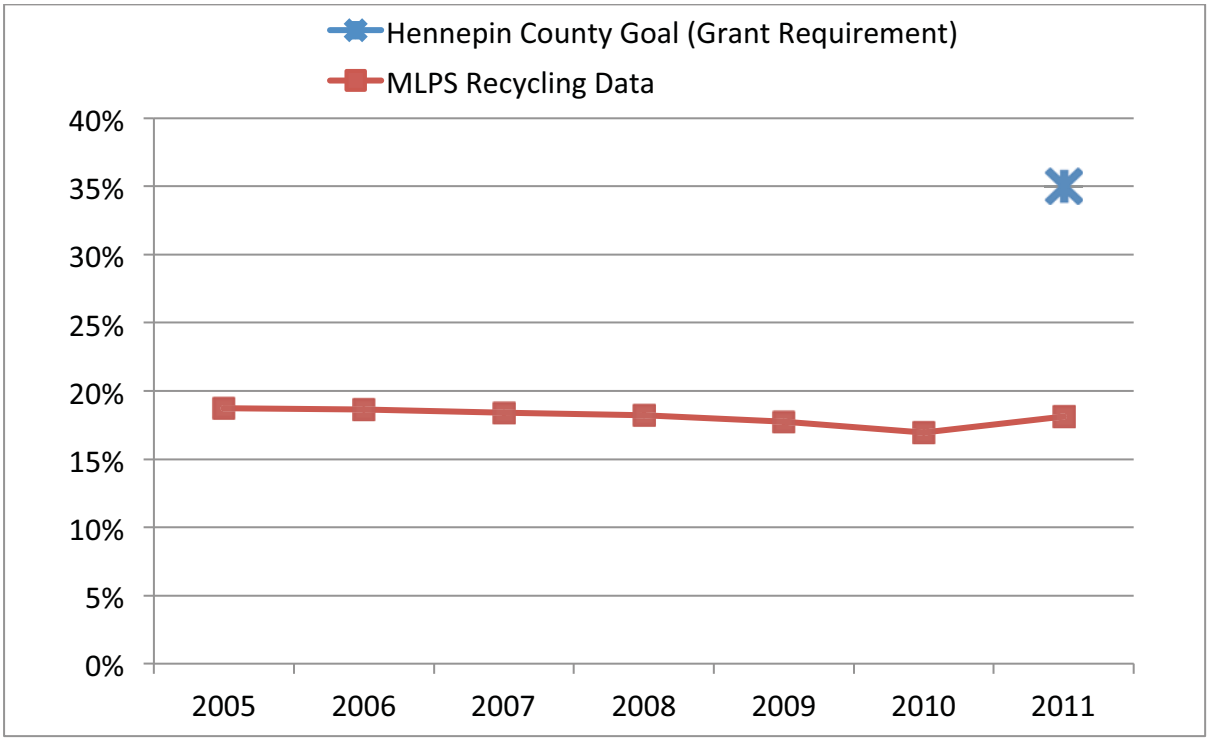
INTRODUCTION & BACKGROUND

Many cities and solid waste districts throughout the nation are setting new, ambitious goals for higher recycling, waste recovery rates and even targeting zero waste as an attainable goal.

The State of Minnesota has established new recovery goals for Hennepin County, which includes 45% recycling rate by 2015 and 47% by 2020. Hennepin County Department of Environmental Services approved a Resolution to establish recycling goals and revise the Funding Policy for recycling grants efforts, establishing a recycling goal of 35%. The goals stated in the Hennepin County Resolution are to increase recycling participation, increase the amount of material recycled and reduce the cost of services. To meet those goals, Hennepin County is considering establishing what materials should be included in recycling programs and requiring implementation of either dual-sort or single–sort collection. A copy of the Resolution is included as Appendix #1.

Minneapolis' curbside recycling program began as a pilot, monthly collection in 1982. Over the years, the number of items collected was increased in the program and the frequency of collection was shifted to bi-weekly service. The collection method has remained as an at-the-curb, multi-sort system, which requires residents to place all items in separate paper bags in their recycling bin. Although the community accepts and supports recycling, for more than 10 years the city has seen a stagnant recycling rate, and in some years, the rate has declined.

FIGURE 1: MINNEAPOLIS RECYCLING RATE AND HENNEPIN COUNTY RECYCLING GOAL*



*2011 Recycling Rate = 18.1%

The challenge facing the City is how to increase the current recycling rate to meet the goals set by the State of Minnesota and supported by Hennepin County, while providing a cost-effective program that can be embraced by its residents and businesses.

SOLID WASTE AND RECYCLING PROGRAMS AND POLICIES

Both state and local government policies play a strong role in shaping recovery in the TCMA. At the state level, Minnesota's Waste Management Act (WMA) (Minn. Stat. §115A), enacted in 1980, establishes the following program goals.

An official hierarchy of waste management methods:

(1) Waste reduction and reuse;
(2) Waste recycling;
(3) Composting of yard waste and food waste;
(4) Resource recovery through mixed municipal solid waste composting or incineration;
(5) Land disposal which produces no measurable methane gas or which involves the retrieval of methane gas as a fuel for the production of energy to be used on-site or for sale; and
(6) Land disposal that produces measurable methane and which does not involve the retrieval of methane gas as a fuel for the production of energy to be used on-site or for sale.

- A statewide source reduction goal to be achieved by December 31, 2000, of a minimum ten percent per capita reduction from the 1993 MSW generation (Minn. Stat. § 115A.55).
- A 50 percent recycling goal for the metropolitan counties, including credits for yard waste and source reduction, which can add up to 8 percent to the base recycling rate (Minn. Stat. § 115A.551).

In addition, Minn. Stat. §473.149 establishes requirements for comprehensive solid waste planning, including setting quantifiable objectives for reducing land disposal in the TCMA region. At the local level, the metropolitan counties have the primary responsibility for creating this plan and managing the integrated solid waste system. The 2008 Minnesota Climate Change Advisory Group (MCCAG)'s recommendations, which are not statutory requirements, also guided the TCMA's solid waste planning process. These include statewide goals of 60 percent recycling and 15 percent organics recycling by 2025 to help reach greenhouse gas reduction goals set by the legislature. The goals established for the metro area are shown in Table 1 below. Hennepin County adopted the goals established by the MPCA in its Policy Plan adopted April 10, 2012 with the exception that the county has an organics recovery goal of 6 percent by 2015 and by 2020.

Table 1: Solid Waste Management Goals

Solid Waste Management Method	2008	2015	2020	2025	2030
Source Reduction and Reuse (minimum)		1-2%	2-4%	3-5%	4-6%
Recycling (minimum)	41%	45-48%	47-51%	48-54%	53-60%
Organics Recovery (minimum)	2%	3-6%	4-7%	5-9%	7-9%
Resource Recovery (expected)	29%	32-34%	34-35%	32-33%	29-30%
Landfill (maximum)	28%	20%	15%	15%	11%

Residential recycling programs consist of curbside collection and drop-off sites, and include recycling services for both single-family and multifamily housing. Curbside recycling programs in the TCMA are provided by haulers through a contract with a municipality or are provided through subscription service. Most counties provide some funding for municipal programs. The private sector, municipalities, and two counties provide numerous public drop-off locations for one or more types of recyclables.

MINNESOTA SOLID WASTE MANAGEMENT TAX

The State of Minnesota also promotes recycling of waste via a Solid Waste Management Tax levied on all mixed municipal solid waste management services. Services for recycling, yard trimmings and other materials separated from the waste sort are exempt from the tax. This has a net effect of increasing costs of disposal and decreasing the relative costs to recycle, thereby encouraging businesses and communities to recycle more. The current Solid Waste Management Tax rates are:

- 9.75% for residential generators
- 17% for commercial generators and self-haulers

The City of Minneapolis tax is calculated and the tax incentive for recycling is shown in Table 2.

Table 2: Solid Waste Management Tax Example

Sample Tax: One residential dwelling unit with a single large garbage cart per month	Calculation	Non-Recycler	Recycler
Base Fee	$24.00 x 9.75%=	$2.34	$2.34
Recycling Credit	$7.00 x 9.75% =		($0.68)
Cart Disposal Fee	$5.00 x 9.75% =	$0.49	$0.49
Total Tax		$2.83	$2.15

WASTE AND RECYCLING INFRASTRUCTURE

Several large incinerators, landfills, and material recovery facilities, as well as numerous transfer stations serve the TCMA. These are shown are listed in Table 3.

Table 3: Disposal Infrastructure

Facility	Location	Material	Tons per Day	Tip Fee ($/ton)	Notes
Landfills:					
Pine Bend Sanitary Landfill	Inver Grove Heights, MN	C&D, MSW	792	$70.00*	Primary recipient of TCMA landfilled waste
SKB Rich Valley Demolition Landfill & TS	South Saint Paul, MN	C&D, MSW	5	N/A	
Elk River Sanitary Landfill, Inc.	Elk River, MN	C&D, MSW	1503	$78.80*	Secondary recipient of TCMA landfilled waste
Burnsville-Kraemer Sanitary Landfill	Burnsville, MN	C&D, MSW	1074	$69.78*	Primary recipient of TCMA landfilled waste
Dawnway Demolition Landfill	South Saint Paul, MN	C&D, MSW	63	N/A	
Lake Elmo-Washington County Landfill	Lake Elmo, MN	MSW	NA	N/A	
Ruby Landfill Township	Maiden Rock, WI	MSW	N/A	N/A	
Incinerators:					
Elk River RDF Processing Facility	Elk River, MN	MSW	1664	$69.00	Refuse-derived fuel processing
NRG-Ramsey/Washington RDF	Newport, MN	MSW, Tires, Wood	1192	$50.00	Converts MSW into refuse-derived fuel, ferrous and non-ferrous metal recovery
Hennepin Energy Resource Company (HERC)	Minneapolis, MN	MSW	740	$47.00	Mass-burn technology with ferrous metal recovery
Transfer Stations:					
Waste Management Transfer Station	Saint Paul, MN	C&D, MSW, Yard Waste	324	$60.00	
Twin Cities Recyco Transfer Station	Blaine, MN	C&D, MSW, Yard Waste	312	$85.00	
Richard's Transfer Station	Savage, MN	C&D, MSW	255	$43.00	
Bellaire Resource Recovery System TS	Stillwater, MN	C&D, MSW, Yard Waste	134	$50.00	
WMI / Northern Wisconsin TS	River Falls, MN	C&D, MSW	100	$55.00	
Dakota Resource Recovery, Inc. TS / United Waste	Inver Grove Heights, MN	C&D, MSW	63	$50.00	
Knutsen Services Inc. TS	Rosemount, MN	MSW	63	N/A	
Freeway Transfer Station	Burnsville, MN	MSW, Tires (Auto)	819	$45.00	
Hennepin County Recycling Center	Brooklyn Park, MN	C&D, MSW, Yard Waste	595	$45.00	
Cambridge SW Transfer Station	Cambridge, MN	C&D, MSW, Ash	136	$49.00	
Minneapolis South Side Transfer Station	Minneapolis, MN	C&D, MSW	4	$88.92	

- Tip fees shown are stated gate rates.

- **Table 4: Processing Infrastructure (Material Recovery Facilities)**

Facility	Location	Material Lines	Tons per Day
Allied Waste Minneapolis Recycling Center	Minneapolis, MN	Mixed Fiber, Commingled Containers (rigids), All Materials-single sort, High Grade Fiber	500
Eureka Recycling	St. Paul, MN	Mixed Fiber, Commingled Containers	180
Inver Grove Heights/St. Paul (Allied Waste)	Inver Grove Heights, MN	All materials	200
Mall of America - Waste and Recycling Department	Bloomington, MN	Commingled Containers, Mixed Fiber-Manual, OCC-manual	31
Pierce County MRF	Ellsworth, WI	Glass-manual, Commingled Containers - no glass, Mixed Fiber	16
Pythons of St. Cloud Inc.	St. Cloud, MN	Mixed Fiber, Commingled Containers, OCC	85
Recycle America Alliance	Minneapolis, MN	Mixed Fiber, Single Sort, Dual Sort containers, OCC	558

A majority of local recycling centers – Material Recovery Facilities (MRF's) – have made significant capital investment on single sort processing.

DISPOSAL COST SUMMARY

Table 5 contains estimates from the TCMA's solid waste plan for the all-inclusive cost per ton for various methods of managing solid waste, taking into account recycling revenue, collection costs, processing costs, and tip fees. Where possible, tip fees and collection costs have been disaggregated. Actual costs from the City of Minneapolis as well as private hauling companies are used in the analysis of program costs.

Table 5: Estimated Costs Per Ton for Solid Waste Management

Management Method	Total Cost per ton	Tip fee	Collection and other costs
Recycling (residential)	$110 -$143	Not applicable	Unable to separate these costs
Recycling (commercial, institutional, and industrial)	$85 - $90	Not applicable	Unable to separate these costs
Organics (Food to animals)	$0 - $49	Not applicable	Unable to separate these costs
Organics (SSO)	$80 - $193	$40 - $45	$40 - $148
Waste to Energy	$168 - $207	$47 - $84	$119 - $123
Landfill	$130 - $162	$39 - $43	$91 - $119

COMPARATIVE CITY INFORMATION

The cities included in the comparative analysis that have single sort systems are Ann Arbor, Kansas City, and Cincinnati. Keeping glass separate from the remainder of the recyclable materials modifies Kansas City's single sort collection.

Table 6: Comparative Recycling Participation Rates

Program	Recycling Rate*
Current MPLS	18%
St. Paul	**30%**
Ann Arbor	**37%**
Portland	**34%**
Kansas City**	16%
Cincinnati**	18%

Communities that have converted to dual sort or single sort collection experience an immediate, significant increase in the volumes collected. Residents do not have to provide as much space for sorting and storing materials in preparation for their collection day, and find it easier to carry materials to the curb in fewer containers. Further, the routes can be expanded to serve a larger number of stops, which saves in truck usage, labor and travel time on the street. It has been demonstrated throughout the country that cart based systems increases the amount of recyclable material that can be collected in a bi-weekly or weekly program.

Table 7: Comparative Recycling Quantity Rates

Program Area	Ann Arbor	St. Paul	Kansas City	Cincinnati	Portland
Recycling Collection	Single Sort Weekly	Dual Sort Weekly	Single Sort Weekly	Single Sort Biweekly	Single Sort Weekly
Container	Cart	Bin	Bin	Cart	Cart
Lbs./HH	726	477	302	386	659

The five comparable cities offer a variety of service combinations to consider. Each has its own success story. Each has adapted to its own program, so additional review would be beneficial in evaluating which options would be the most applicable.

Table 8: Comparative Recycling Changes

Ann Arbor	Saw 15% increase in tonnage with switch from weekly dual sort bins to single sort carts
St. Paul	Saw 15% increase in tonnage with switch from source separated biweekly bins to dual sort weekly bins
Cincinnati	Saw participation increase from 40% to 71% with switch from weekly bins to biweekly carts
	Switch saved city $900,000 per year
	Tonnage increased by over 50% in same time period

Carts versus bins: Carts have consistently shown an increase in the volume of recycling collected. Carts offer greater capacity, more stability and decreased risk of materials becoming wind-strewn or placed in trash when the bin is full before collection. There are concerns, as noted in the later section entitled 'Curb Set Out Options',

about the size of the carts and difficulty in handling to the curb. However, with consistent, user-friendly education and if carts are offered in size options, carts yield greater participation and volumes.

Waste versus recycling: The combination of waste and recycling collection remains a factor in recovery rates. If unlimited waste disposal, at a low rate of cost is offered to a community, it is very easy to put everything into a waste container. Successful programs focus on discouraging waste disposal and encouraging recycling, composting and source reduction as the better alternatives. This can be accomplished through education and encouraging participating in the recycling programs and through the variable pricing of waste disposal. Where these factors are present, recycling programs tend to be much more successful in both recovering material and generating revenue.

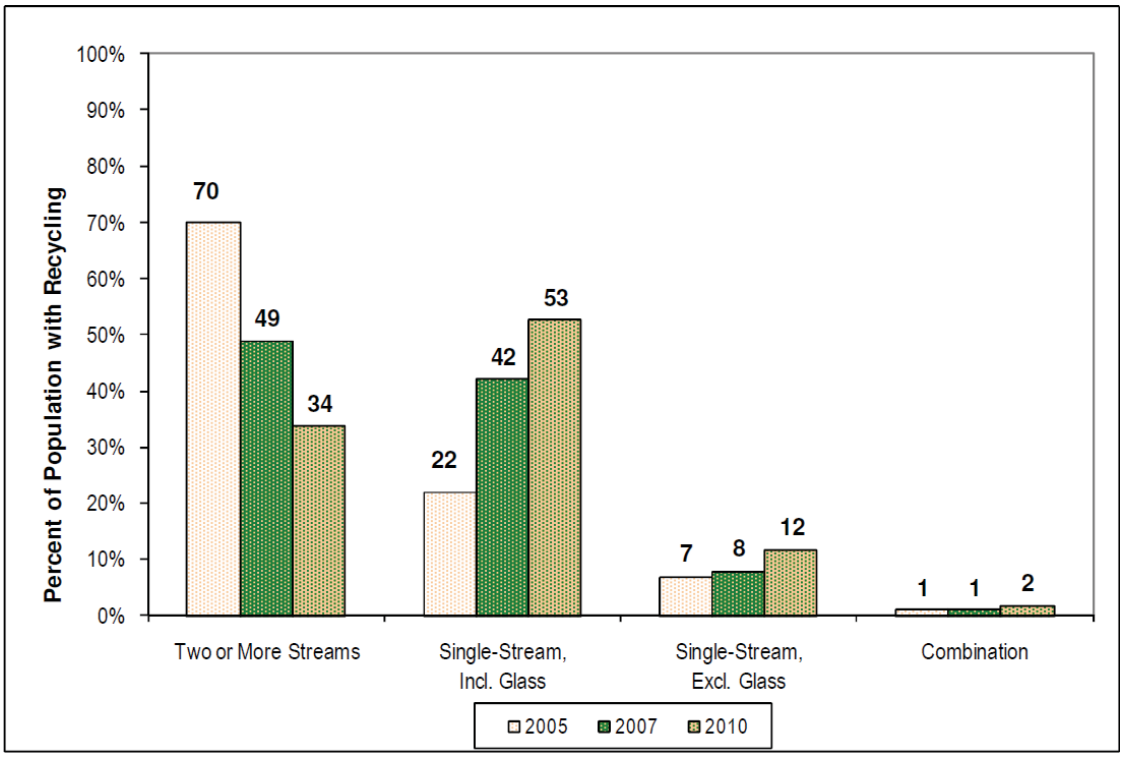
Frequency: Many communities have resorted to bi-weekly recycling collection as a cost savings. Communities attaining high recycling rates in the compared cities provide weekly collection. Weekly collection provides residents with a simpler "everything out to the curb" model. Bi-weekly as an option in the interests of cost savings must be balanced by providing adequate containers and reminders of the collection schedule to avoid recyclables being disposed in the garbage because the resident "ran out of room" in the recycling bin.

Cost: Converting to a dual or single sort collection system requires some capital investment in equipment, program modifications and public education. Changes in processing fees will be dependent upon the arrangement with the MRF and the revenue sharing arrangement established with the City. These investment factors are balanced against the increase in recycling resulting from a simpler method of setout and collection for the community, and the savings realized from reduced waste disposal fees and collection costs.

CHANGES IN COLLECTION SYSTEMS

Single-sort recycling – where all fiber grades and recyclable containers are collected commingled together in one compartment on the recycling collection vehicle – has been a growing trend for the past fifteen years. The prevalence of single-sort collection was first evaluated in the 2000 Survey, and has continued to be evaluated in the subsequent surveys. As shown in Figure 2, the growth in single-sort recycling has steadily increased. In 2005, only 29 percent of the population with recycling had access to a single-sort program. By 2010, that number has increased to 64 percent. Although R. W. Beck has not attempted to correlate the trend to single-sort collection with the expansion in fiber products collected in programs, anecdotal evidence suggests such a relationship exists.

FIGURE 2: 2007 VS. 2010 COMPARISON: PERCENTAGE OF COMMUNITIES BY COLLECTION METHOD [1]



* "Combination" means different haulers in some communities may use different collection techniques for recycling collection

RECYCLING COLLECTION OPTIONS

RRS conducted a comparative analysis of five cities' recycling collection and processing programs. The intention of this analysis was to gather data from comparable cities to provide an overview of each one's experience with possible options that can be incorporated into Minneapolis' program. RRS then evaluated both dual sort and single sort collection options based on the assessments of other cities, reports on collection and processing efficiencies, truck vendor information, an evaluation of the constraints to collection imposed by the collection of recyclables in alleys, and a series of focus groups with City residents.

[1] Copyright © 2012 Paper Industry Association Council
[2] *Resource Recycling Magazine*, October, 2009
[3] *Single-Stream and Dual-Stream Recycling: Comparative Impacts of Commingled Recyclables Processing*, Prepared For the

The five cities, Cincinnati, Ann Arbor, St. Paul, Kansas City, and Portland, have all converted their collection programs from long-term, curbside multi-sort collection programs to variations of dual-sort or single sort collection at the curb, and weekly or bi-weekly frequency.

CURRENT MULTI-SORT COLLECTION PROGRAM

The Minneapolis program is a curbside multi-sort program. Collection vehicles used in a multi-sort system are designed with multiple compartments. If two or more items are combined in a compartment, the multi-sort is a variation, which requires some level of sorting at the MRF.

Collection quantities are limited in multi-sort programs by complex sorting requirements for residents. In the early years of curbside recycling, the number of compartments on a collection truck was adequate for the materials included in the program: steel cans, newspaper, cardboard, aluminum cans, glass sorted by clear and color, and sometimes #1 and #2 plastic bottles.

Minneapolis Recycling Collection Truck

As recycling markets and resident demand for more recycling increased, multi-sort programs were challenged to adapt and provide additional recycling opportunities. The marketplace addressed these challenges with first dual sort (or dual stream) and then single sort (or single stream) approaches to recycling collection and processing were developed.

Another limitation to the multi-sort programs is the amount of materials that are collected on the route. When one of the compartments is full, the truck must return to the MRF to empty the load, even though other compartments have remaining capacity. This requires a greater number of trips to and from the MRF. The route cannot serve the full potential of stops, which makes the vehicle and the collection route inefficient, and subsequently increasing labor and travel costs. To an extent, the percentage of materials collected in a residential mix can be projected. This could allow for a larger capacity compartment to be designated for, perhaps, newspaper. However, on any given route the percentage may vary.

Multi-sorted programs require the most costly labor to collect the materials. Emptying the containers/bags of recyclable materials into the respective compartments is a repetitive motion, requiring more time (labor hours) at each stop than other systems. In terms of labor costs, truck drivers are paid at a higher rate than laborers working at a MRF. The time consumed by the driver to collect the recyclables is an additional cost to the program.

DUAL-SORT COLLECTION PROGRAM

In a dual-sort system, paper (fiber) is collected separately from containers (cans, bottles, plastics). Trucks are equipped with a split body or two compartments, so that fiber is placed in one of the two compartments and containers are placed in the second compartment. The dual-sort collection is a more efficient system than the multi-sort collection in terms of time and costs. Filling the truck requires two repetitive motions to collect the materials. This saves collection time at the curb. The disadvantage of dual sort collection remains, though less problematic, as the multi-sort system; when one side of the truck is filled, the truck must return to the MRF to empty the load and return to the route. Saint Paul, Minneapolis's "Twin City", employs a dual-sort recycling collection and processing system. Data from Saint Paul is presented as part of this study.

SINGLE-SORT COLLECTION PROGRAM

An increasing number of communities have shifted to a single sort collection system. In a single sort system, all materials are collected and placed in a single compartment truck. Each collection vehicle can remain on route until the truck is completely full or the route is complete. Even in that case, dispatchers may send a less than full truck to another route to help complete collection, based upon proximity and capacity of the truck.

The trucks can be dual-purpose, i.e., collect recyclables and then designated to return to assist in waste or other materials collection. The driver makes a one motion pass at each stop, saving time and labor costs. If the truck is equipped with a mechanical loading hopper or mechanical arm, the driver can save additional time in the collection process. (See photos below)

Semi-Automated Collection Truck

Automated Recycling Collection Truck

CURB CONTAINER SET OUT OPTIONS

There are two container options communities can offer residents to set out materials for dual and single sort curbside collection. The first option is to provide one or more recycling bins, i.e., plastic boxes of varying size, typically ranging from 13 gallon to 25 gallon While recycling bins can be equipped with lids, the disadvantage to bin programs with lids is that the lightweight lid can be damaged if it falls or blows into the street, or completely disappear if weather conditions are amply strong. In a dual collection system, residents either have two bins, one for fiber and one for containers, or are asked to place all fiber into a paper bag to isolate from the containers and place everything into the single container.

The second option for curbside set outs is a wheeled cart, equipped with an attached lid. Wheeled carts have been the most accepted and growing option for single and dual sort collection programs over the past 10 years. The wheeled cart encourages residents to recycle more materials and provides the convenience of storage of

materials and for hauling to the curb. The most expressed reservation from residents concerning multi-sort programs, the number of containers and the difficulty of moving all of them to the curb without spillage, is also one of the advantages of the cart.

There are circumstances where some residents are concerned that the cart is too big or heavy to move to the curb, especially for the elderly. Operational experience has shown that although cart size can at first be somewhat intimidating, the resident adapts to the cart and its transport and storage options. Optional programs that allow for residents to request a different size cart can also be implemented as part of a switch to cart based programs. Dual sort systems can also use carts, either split 96-gal or two 64-gal for biweekly collection.

Photo: Typical Recycling Carts and Bins

Communities can allay these concerns by first, displaying the carts in a prominent location so residents can "check them out" prior to the onset of a program or by offering an optional smaller sized cart. It can also be pointed out that communities seem to have no problem when providing a trash cart of the same size. Also refer to offering smaller carts for the elderly

Some cleanliness improvement has been identified with the implementation of carts. A larger container with a cover prevents much of the litter and blowing of paper and plastic that is associated with lidless bin containers. In addition, some residents have indicated that storing recyclables outside in a cart is preferable to keeping bins indoors. This is especially helpful in areas providing alley collection.

Table 9: Cart Options

Criteria and Specifications	Rehrig Pacific	Cascade	Toter	Otto
Expertise	21 years experience with roll-out carts, company founded in 1913	22 years experience, 17 million carts	Largest cart manufacturer in US	Largest cart producer worldwide, US operations include at least 24 cities
Product	HuskyLite rollout carts, injection molding	Injection molding HDPE	Advanced Rotationally Molded	Injection molding
Cart Manufacturing	5 manufacturing facilities in US	1 facility in Grand Rapids, MI	1 facility in NC	2 facilities AZ, NC
Incentive Programs - Recyclebank (RB), Rewards for Recycling (R4R) and RFID tags	Certified by RB, worked on 9 RB projects, maintains RB carts; company using RFID tags for 3 years and has over 1 million in the market	Worked with RB in Philadelphia and other projects	Toter designed, built and patented the Weight in Motion Cart Lifter/Scale and RFID technology	Not Available
Assembly and Distribution	In house	In house	Outsourced delivery and maintenance to Next Level Transportation Services	Not Available
Typical Delivery Timeframe	76 days @ 8400 carts/week	8 weeks @10,000 carts/week;	58 days @ 12,000 carts per week	Not Available
Staffing for delivery	4 delivery crews made up of 6 people; 4 trucks	2 delivery crews made up of 5 people	Not Available	Not Available
Customer support	Live administrative support offer 8-5pm	Minimum 1 person, 1 truck, city facility	Local service office	Not Available
Warranty	10 years	10 years	10 years	10 years
Resin pricing provided	No	Yes	No	Yes

COLLECTION ASSESSMENT

LOCATION: ALLEY VS. CURBSIDE

Historically, refuse and recycling is set out and collected via the City's extensive alleyway system. Residents and the collection team prefer the alleyways as it facilitates an easier set out and collection than a street side pickup. Because the street is heavily utilized for parking, any additional space required for curbside pickup would prove challenging and is not recommended.

WIDTH AND TURNING RADIUS

Eighty percent of the City's collection points are located in alleys. Any new collection system will need to adapt to the narrow characteristics and challenges found throughout the city.

The average right-of-way in a Minneapolis alley is 12' with 1-2 ' of unpaved curb. There are areas where this is as narrow as 8.5'. In winter months, considerable amounts of snow do accumulate on either side of the alley, effectively narrowing the width even more.

Routes also include a full range of traffic flows, from "T" and "L" turns to dead-end alleyways that require backing a vehicle into position. To complete the routes effectively and safely, RRS finds that only 96" wide chassis should be considered as well as trucks with at most, a 27' turning radius.

HEIGHT RESTRICTIONS

The alleyways are also home to a network of overhead utility wires that crisscross alleys at 12' to 14' high. Many carts are also placed under garage overhangs with a similarly low 12' clearance. This fact, coupled other obstructions, has lead RRS to recommend vehicles with a maximum riding height of 11'9". The height clearance restrictions also make other collection options difficult to operate if not totally removing them from the realm of possibility.

OPTIONS

Considering the constraints of maneuverability, cart placement, general conditions and available technology RRS suggests narrowing the focus to 20-23 cubic yards per day (CYD) rear load packers and smaller semi automated side loaders.

Standard, fully automated side load systems lift carts well above the obstruction height and then tip the contents into a hopper. This system requires considerable height clearance, proper cart placement, and a wide enough road to allow the lifter arm to operate. With current available technology, this option isn't viable.

Semi-automated side load systems require a worker to hook a recycling cart to a lifter arm that then mechanically dumps into the truck. This system is still a feasible option, but requires a proper height clearance that is problematic in many parts of the City.

The more traditional type of refuse/recycling truck setup is the rear-loading packer. In this system a worker rolls carts to the lifting mechanism at the rear of the truck, and the contents are then mechanically dumped into the truck. This option requires the least amount of height and width clearance to operate and works best of the options noted, in the alley system operating in Minneapolis.

Table 10: Recycling Collection Options (Bodies)

Criteria	Crane Chassis With Leach Body	Heil 40-60 Rear	Labrie Expert 2000	Labrie Expert 2000 (Dual)	Lodal 50/50*
Type	Rear loader	Rear loader	Side Loader	Side Loader	Side Loader
Single/Dual	Single Sort	Dual Sort	Single Sort	Dual Sort	Dual Sort
Cycle time (Seconds) (Time per Stop)	20	15-17	20	20	Not Provided
Capacity (cubic Yards)	20	20-25	22	17-24	23
Price **	$152,000	$180,000	$161,700	$173,700	$230,000
Height Clearance					11.5'
Height Above Frame (Body)		98"	102''	102"	

*Includes chassis and bodies
** Cost does not include cart lift mechanism or other body modifications

Based on the assessment of the constraints posed by the collection of recyclables in alleys, discussions with the City of Minneapolis staff and on discussion with truck vendors it was determined that rear load 20 cubic yard capacity trucks with short turn radius was the only viable option for the collection of recycling materials.

PILOT COLLECTION PROGRAM

Minneapolis conducted two pilot programs, testing the effectiveness of dual-sort and single-sort collection. Both pilot programs incorporated recycling carts and collecting on the bi-weekly schedule. The results from these pilots programs show a significant increase in number of stops that can be served by a single route and the quantity of recyclables collected per household. These increases yield a higher recycling rate for a community, a reduced number of routes, fewer trucks required for collection per household.

Table 11: Pilot Performance Metrics

Program	Increase in Stops	Increase in Weight	Avg. lbs./HH/Yr.
Single Sort			
High Performing Neighborhood	34.6%	31.0%	592
Low Performing Neighborhood	74.6%	77.0%	338
Dual Sort			
Average Performing Neighborhood	92.6%	28.8%	474
Current Multiple Sort for Participating HH			405
Current Multiple Sort for All Dwelling Units			343
St. Paul, MN Dual Sort All Dwelling Units			477
Portland, OR - Single Sort			659

Currently the City of Minneapolis uses side load multi sort trucks to collect curbside recycling and is in the process of reviewing options for single and dual sort collection. RRS explored the best options in collection vehicles, evaluated key features, and broadly associated a price to the various selections, including automated, semi-automated, and manual load trucks. The City of Minneapolis collection routes include obstacles and unique considerations that limit the range of viable options.

FOCUS GROUP MEETINGS

Focus Group meetings were held in two quadrants in the City which are currently provided with traditional, curb-sort recycling collection and one meeting in each of the areas of the city that experienced pilot programs of alternative collection services: one section participated in dual-sort collection, then transitioned to a single-sort and one section participated in a single-sort collection. The meetings were held in the residents' neighborhoods, in local Park recreation buildings' meeting rooms.

The Groups were identified as: Group A Northeast Quadrant, Multi-Sort Curbside Service
Group B Southwest Quadrant, Multi-Sort Curbside Service
Seward, Pilot Program, Dual Sort then Single Sort
Willard Hay & ECCO, Pilot Program, Single Sort

The Focus Group participants were invited to attend the meetings by random selection of telephone numbers published in the city directory. Specific addresses and names of individuals were unknown. A telephone call script was prepared to provide a standard format to invite residents to participate in the group meetings.

The groups were intentionally kept small, which provided the opportunity for neighbors to meet and share his or her attitudes towards recycling, recycling habits and discuss the service that would best meet their expectations and needs for recycling.

The meetings followed an agreed upon format. A brief review outlined the reasons the City is evaluating recycling collection options and the potential impacts of any changes, based upon other communities' experiences. The possible options for increasing recycling in the city and collection options were presented. Key questions were prepared as guidelines to enable a conversation style for the meetings.

MEETING PARTICIPANTS

All participants have been recycling for a number of years, some for decades. Participants were a mix of ages and family circumstances, including retired, young family with infant, grandparents who provide daycare for grandchildren.

Every person participated and offered insights, experiences and support of improving the recycling program. Each group also, via individual comments and observations, expressed their appreciation for the city's efforts to evaluate and improve services and was aware that the city would be evaluating any service changes in terms of the final cost for service and equipment.

The participants in all the groups expressed an interest and commitment to recycling that stems, in part, from a desire to improve the environment and an awareness of other sustainability and green initiatives. Though everyone did identify themselves as recyclers, there was a range of recycling awareness and participation levels. In the area served by the single sort pilot program, a resident did acknowledge that she is recycling more now that the program has been simplified.

ATTITUDES TOWARDS PROGRAMS AND COMPARABLE EXPERIENCES

There was an almost even division of life-long Minneapolis residents and those who have lived in other communities. However, everyone has visited relatives or friends in other communities and has hosted guests in their homes. This allowed a productive discussion of comparisons to the acceptance and ability to recycle in various programs.

In the areas that have the established multi-sort curbside service, the participants expressed a desire and support making the program simpler. The discussion covered the issue of simplifying the program to encourage all the residents to participate at greater levels.

In the areas that have the pilot programs, the participants preferred the single-sort to the dual sort program. Both programs were preferred to going back to the multi-sort system. One resident in the single sort pilot area acknowledged that she recycles much more now that the program has been made simpler. In both pilot program areas, there is agreement that recycling participation and volumes have increased.

Those who have lived in other communities have experience participating in single-sort collection, though most have also visited relatives or friends who have an alternative to the multi-sort recycling program. Those who have experienced single sort recycling felt it was simpler to participate and did not see any negative issues. One resident commented that visiting relatives and friends often aren't very helpful because they don't understand the multi-sort program.

Two of the groups included duplex owners, in which the owners occupied one of the units and the second was rented. One of the groups was the multi-sort service and the other was in the dual-sort to single-sort pilot area. The duplex owners shared their experiences that renters are less inclined to recycle and their frustrations to encourage participation by renters. These residents share the perspective that too many neighbors do not participate or support recycling and have a keen desire to have the program improved to increase participation and volumes collected.

The duplex owner from the single-sort pilot area brought her tenant with her. This provided an opportunity to hear different perspectives, although the renter's attendance was indicative of the commitment to recycling.

The discussion and suggestions from the duplex residents included:

- Less commitment to recycling, the connection to the community is not as strong, renters move and a new renter must be informed about the program.
- Difficulty of the multi-sort system for tenants, multiple containers in a smaller space, outdoor container storage space
- Not "required". One duplex owner has written into the lease that the renter must participate in the recycling program.

In terms of recycling setouts, only two have curbside collection. All the residents with alley collection do not want collection to be switched to curbside. In some portions of the city, switching to curbside would pose a hardship, where there are steps to the curb and street and limited space at the curb. In addition, parked cars, traffic flow and the aesthetics were viewed as restrictive to changing the collection.

RECYCLING CARTS AND BINS

Residents in the multi-sort service areas shared their experiences and the challenges of setting out multiple containers. Some even shared tips with each other to make setouts easier. A couple of the residents expressed guilt about going to the grocery store and asking for additional paper bags to use in their recycling program. One resident carries cloth bags for grocery shopping, yet needs to obtain paper bags to recycle. Most acknowledged that if they don't have a full bag for a particular item, they consider whether to save and store the bag for another week or throw the items in the garbage.

Both duplex residents and single-family home residents supported increasing the size of recycling containers. For those in the pilot areas, the recycling cart was well received and viewed as a plus for the programs and one resident even hoped she would not have to return her cart at the end of the pilot program. No one felt there were space problems in storing the larger cart.

In all the areas, when discussing the recycling carts, there was discussion and support for offering size options for residents based on household size and recycling generated. This led to an observation that the waste cart could also be reduced as recycling participation increases.

RECYCLING AWARENESS AND EDUCATION

Most of the residents were very aware of the recycling program, what is included and how to set out materials. If there is doubt about an item, residents acknowledged they throw it in the garbage.

Very few seemed aware of the City's website or have accessed the information provided. The primary source of information for the residents is the mailed flyer or brochure. Every resident was aware of the information on the flyer and many indicated where the brochure is stored or posted in the home as a reference. One of the residents especially noted the quality of the graphics and the information presented. Several supported providing a laminated version that could be posted in the home. In the pilot areas with recycling carts, residents thought a laminated version could be placed on the cart.

There is general support for increased education, outreach and events to increase awareness of recycling in the community and to encourage participation. Some of the suggestions and discussion included hiring an educator

or coordinator, providing programs in the schools to help develop life-long recycling habits, organizing a team of volunteers who could make presentations in schools or to groups, organizing tours of recycling facilities.

SPECIAL PROGRAMS AND ADDITIONAL SERVICES

Questions concerning special collections or recycling programs were not a part of the planned discussion. However, every group mentioned how much they appreciate and want to see continued collection of bulky items, recycling of electronics and the household hazardous waste programs. Several residents were also interested and would like yard waste or organics recycling collection added to the program to enhance the recovery of materials in the community. Residents are very happy that milk cartons and other types of cartons were added, it adds to the recycling program.

All the groups discussed and agreed that reaching the recycling rate goal in the city would most likely need to include multi-family services. The residents recognized that providing or requiring that multi-family units with recycling service would be a longer-range goal that needs study and consideration.

COMMENTS

Each group quickly became comfortable in discussing the programs. Following are comments made during the discussions:

- Preference for single sort, weekly collection; every other week can be confusing.
- Containers equipped with lids were preferred, to reduce litter, weather degrading the materials and animals getting at the recycling.
- The single sort system is easier to explain, especially for residents who have moved from other communities that offer a simpler system. The simpler you make the program, the more participation and amount of recycling will occur.
- Would prefer single sort to dual sort because would have to store additional recycling carts.
- Need more education about recycling and ways to be more environmentally responsible in general.
- Would like to see more items added if possible (plastic bags, egg cartons, other plastics, pizza boxes).
- Enforce some sort of penalty for not recycling
- Renters pose special challenges, the recycling program has to be explained and renters have to be encouraged to recycle.
- Giving some form of credit for recycling is nice, but not necessary. If the rebate for recycling were eliminated, it would not change the desire to recycle.
- Suggested if a reward is provided for recycling, it should be based on giving a higher reward for those who recycle more.
- Provide any incentives that help encourage recycling, anything that works.
- Supports whatever it takes to reach the recycling goal established by the County.
- Love the recycling cart and don't want to return it when the pilot program ends.
- Have seen more participation in the neighborhood, sometimes thought no one else recycled on the block when putting out materials before the pilot program started.
- Realize that recycling saves money for the city, this should be promoted to the residents, and explain the payback to the residents. If tipping/disposal costs are reduced, the money saved is actually a savings for residents.

COLLECTION OPTIONS ANALYSIS AND COSTS

An analysis of the performance and costs associated with transforming the Minneapolis collection program from a multi-sort to a dual or single sort system was developed to provide a comparative assessment of the different approaches. Although fully automated systems were evaluated, given the constraints presented by collection in alleys it was determined that semi automated rear load collection options would be presented in this report. This method of collecting recyclable material is also consistent with the consideration of collecting yard wastes and other residential and commercial organic wastes through cart based collection programs.

Assumptions were developed based on the analysis of programs in other cities that have dual and single sort collection programs and on the pilot collection programs conducted by the City of Minneapolis. The three key assumptions derived from this information are the participation rate, the number of stops per day that a collection truck can achieve in a constrained alley environment, and the increase in the amount of material that participants will recycle on an annual basis. Other related assumptions include the size of the cart and the capacity of the collection vehicle.

Table 12: Program Assumptions

Options	Current Multi-sort Baseline	Single Sort Semi Auto Biweekly	Single Sort Semi Auto Weekly	Dual Sort Semi Auto Biweekly	Dual Sort Semi Auto Weekly
Size of Cart (gals)		96	64	2 x 64	1x64 1x32
Number of Carts for City Only Households		52,594	52,594	105,188	105,188
Participation Rate	84.5%	90.0%	90.0%	90.0%	90.0%
Lbs./HH/Year (Participating HH)	405	600	600	500	500
Lbs./HH/Stop	15.6	23.1	11.5	19.2	9.6
Stops per Day per Truck (Avg. City Route)	318	676	676	609	609
Truck Capacity (Cubic Yards)	20	20	20	20	20

The relationship between participation rate and the quantity of material that is recycled is a difficult variable to balance. Minneapolis is characterized by a fairly high average participation rate but a low quantity per household. This is explained by two factors. First, there are low performing neighborhoods in terms of both participation and the quantity of material. Second, although there are high performing neighborhoods the quantity of material set out is very low in comparison to other cities. Although there is no data to statistically determine what the variations are on a neighborhood-by-neighborhood basis it was evident in the focus groups that even highly motivated residents did not recycle all the material that the city accepts, primarily due to the difficulty of separating the materials into nine different collection sorts.

The frequency of collection on a weekly or bi-weekly basis has a major impact on the costs for trucks and staffing. The current recycling program operated by the City of Minneapolis with city staff consist of a biweekly pickup serviced by small trucks with pup trailers. In effect, half the households receive service one week and the other half receive service on the alternate week. These fourteen multi sort trucks are each operated by a single employee. Converting the collection program to a semi automated rear load collection truck results in a similar operation level as the waste collection system that is also a semi automated rear load operation.

This means that there would be two staff per truck in this new configuration for a bi-weekly collection program. Given the nearly 200% increase in the number of pickups per day that a semi automated truck can achieve over

the current multi-sort program the impact is that half the trucks are required while maintaining the same staffing level. A change to a weekly collection program would require double the number of trucks and a doubling of the staff required to collect all households on a weekly basis. The collection time for single sort is less than dual sort and there is no need to come off route when one compartment fills before the other.

Table 13: City Only Collection Operating Costs

Program Area	Current Multi-sort Baseline	Single Sort Semi Auto Biweekly	Single Sort Semi Auto Weekly	Dual Sort Semi Auto Biweekly	Dual Sort Semi Auto Weekly
Labor with Benefits	$1,031,338	$1,098,333	$2,036,263	$1,232,323	$2,304,243
O&M	$488,400	$293,200	$464,000	$324,600	$519,800
Education	$0	$100,000	$100,000	$100,000	$100,000
Customer Service	$174,537	$174,537	$174,537	$174,537	$174,537
Total Annual Cost	**$1,694,275**	**$1,666,070**	**$2,774,800**	**$1,831,460**	**$3,098,580**
Percentage Cost Change		-1.7%	63.8%	8.1%	82.9%

The costs for the weekly and bi-weekly collection program for dual and single sort were based on the current labor cost structure and the cost for purchasing rear load semi automated trucks as currently operating in the waste fleet with the same cart tipping system. The operating and maintenance costs were adjusted based on the number of trucks. The total annual cost based on current City of Minneapolis accounting practice illustrates that dual and single sort bi-weekly programs can be implemented with very small impacts on the current operating costs for the City.

Capital Costs for the collection vehicles were based on the most recent truck purchase for rear load semi automated trucks with dual tippers. Dual sort collection requires significant truck capital purchase of dual rear load split body packers ($30,000 more than single rear load). Cart cost for single sort (1 per unit) is estimated at $6,800,000. Cart cost for dual sort (2 per unit) is estimated at $10,500,000. The total costs for new trucks for a City of Minneapolis single sort; bi-weekly collection program is $8,840,000.

Table 14: Projected Capital for Collection Program

Options	Current Multi-sort Baseline	Single Sort Semi Auto Biweekly	Single Sort Semi Auto Weekly	Dual Sort Semi Auto Biweekly	Dual Sort Semi Auto Weekly
Size of Cart (gals)		96	64	2 x 64	1x64 1x32
Number of Carts		105,226	105,226	210,452	210,452
Number of Trucks (includes extra)	16	8	15	9	17
Total Cart Cost		$6,839,690	$6,839,690	$10,522,600	$9,470,340
Total Truck Cost	$3,952,000	$1,976,000	$3,705,000	$2,475,000	$4,675,000

The projected potential recycling rate and the quantity collected increase substantially from the current program in all scenarios for single and dual sort programs. The bi-weekly programs can be implemented with a low cost impact if any and can achieve much higher recovery rates. A single sort system will increase material quantity recovered by 60% and the Minneapolis recycling rate increases from 18% to 32% (based on case studies such as Ann Arbor and Portland). A dual sort system will increase material quantity recovered by 36% and the Minneapolis recycling rate increases from 18% to 25% (based on case studies such as Ann Arbor and Portland). Although the total program costs for both the single sort and dual sort bi-weekly programs are similar the cost per ton is much lower then the current multi sort bi-weekly program.

Table 15: Projected Collection Program Recovery and Metrics

Options	Current Multi-sort Baseline	Single Sort Semi Auto Biweekly	Single Sort Semi Auto Weekly	Dual Sort Semi Auto Biweekly	Dual Sort Semi Auto Weekly
City Tons per Year	9,010	14,200	14,200	11,833	11,833
Total Tons per Year	18,026	28,411	28,411	23,676	23,676
Percent Recovery Curbside * (Rec/MSW)	18.1%	31.9%	31.9%	25.2%	25.2%
Cost/HH City Collection	$32.21	$31.68	$52.76	$34.82	$58.92
Cost/HH/Month City Collection	$2.68	$2.64	$4.40	$2.90	$4.91
Cost/ton City Collection Only	$188	$117	$195	$155	$262

* A Recovery Percentage of 35% is achieved with 650 lbs./HH/Year

The final analysis includes the impact on the revenue and disposal costs on the overall program costs. The net revenue decline for all the new collection scenarios is due to the projected increase in processing fees. These increase in costs are offset by the cost savings from the reduction in disposal fees paid to the Hennepin Energy Resource Company (HERC). Appendix II details the projected tonnage and net revenue.

Table 16: Projected Net Recycling Costs

Options	Current Multi-Sort Baseline	Single Sort Semi Auto Biweekly	Single Sort Semi Auto Weekly	Dual Sort Semi Auto Biweekly	Dual Sort Semi Auto Weekly
City Collection	($1,694,275)	($1,666,070)	($2,774,800)	($1,831,460)	($3,098,580)
MRI Collection	($1,694,593)	($1,666,371)	($2,775,301)	($1,831,791)	($3,099,139)
Total Collection Cost	($3,388,868)	($3,332,441)	($5,550,101)	($3,663,251)	($6,197,719)
Material Revenue*	$1,640,937	$1,280,504	$1,280,504	$1,067,087	$1,067,087
Net Recycling Costs including Revenue	**($1,747,931)**	**($2,051,937)**	**($4,269,597)**	**($2,596,164)**	**($5,130,633)**
Value of MSW Diverted	$847,231	$1,335,318	$1,335,318	$1,112,765	$1,112,765
Net City Recycling Costs (Annual Cost -MSW Diverted	($900,701)	($716,619)	($2,934,279)	($1,483,399)	($4,017,868)

*Assumes a Processing cost for SS/DS = $70.00 and a Current Processing Cost = $24.04

The Net Recycling Cost is the lowest for the Single Sort Semi Automated Bi-weekly collection program by approximately 20% while achieving a 32% recycling rate. The Dual Sort Bi-weekly program has a net cost of approximately 56% higher then the current multi-sort program and achieves a 25% recovery rate. A ten percent increase in the quantity of material collected in the dual sort program achieves a 28.5% recycling rate with a net cost that is 28% higher then the current program.

RECYCLING INCENTIVE PROGRAMS

We are all familiar with the old adage "one mans trash another mans treasure." New companies are trying to change that. They say your trash is your own treasure, because you're going to pay you for it. The concept, called Incentive Based Recycling, is to increase recycling rates by providing a direct financial incentive for people to go through the trouble of sorting their garbage. Participating customers receive a 35, 64, or 96-gallon container that has a barcode that identifies their home. As the truck collects the recycling it scans the barcode

on the container and translates the value of the recycled items into a dollar amount - that can be redeemed though shopping coupons at participating businesses. The two major programs are: Recyclebank and *Rewards for Recycling*.

Participants use an online interface to choose which coupons suit them best, order the coupons and receive them by mail. Alternatively participants can choose to donate their Recyclebank Dollars to charity. Recyclebank serves both residential and retail customers. Many paper, plastic, metal and glass recyclables are collected and the company supports a single sort recycling system that allows all types of recyclables to be deposited in one single container. Home collection of e-waste is coming soon but in the meantime customers can send in cell phones for recycling by printing a envelope label including stamp directly from the website.

Recyclebank trades the actions a customer makes that have a positive impact on your home by saving energy, community by recycling and the environment by conserving natural resources for points that you can use for rewards you choose. Those rewards come in a variety of options: Products, discounts and coupons from the world's leading brands (think: Kashi, Footlocker, Dunkin Donuts), or by donating your points to support environmental education in schools.

Because Recyclebank offers coupons and other economic incentives to recycle, the RecycleBank model is particularly attractive to lower-income communities. By rewarding households with coupons for groceries or services, RecycleBank is having a direct positive impact on family budgets. Therefore, recycling becomes something households participate in for financial assistance, rather than altruistic reasons. This is not meant to suggest that the only people participating in RecycleBank are those on the lower end of the income spectrum, only that the incentives inherent in the RecycleBank model become increasingly attractive the lower on the spectrum a household lays.

Rewards for Recycling was founded in late 2008 with the express intent to provide a better recycling affinity program option for municipalities and waste haulers. The Recycle Bank program was closely studied and evaluated, and R4R was designed to be uniquely different, addressing all of the challenges we found in the alternate system. The R4R program founders identified multiple challenges in the alternate system, specifically a lack of understanding of basic marketing and consumer behavior patterns.

Rewards for Recycling is a community based Recycling program. R4R partners with the municipality, the residents, the community and the local businesses. *Rewards for Recycling* rewards frequency and loyalty for building recycling as a household habit. The program is open and available to all members within the community. *Rewards for Recycling* provides rewards to every household immediately upon start-up, and continues to provide smaller value rewards to all households regardless of recycling activity. This methodology provides the opportunity to continuously convert non-recyclers by showing them the rewards of significantly higher value that will be available to them as soon as they begin recycling.

Local Business participation is a key component of the *Rewards for Recycling* program. The R4R Program features rewards that come from the businesses located within each community. Restaurants, Pharmacies, Dry-cleaners, Oil Changes and other retail products and services. The majority of them are locally owned and operated, and employ local people.

The revenue generated by these businesses stays home and supports the local economy. R4R gives each business an opportunity to offer valuable savings to residents free of charge. These offers can drive traffic to local business. In addition, *Rewards for Recycling* has multiple promotional options available for local businesses that can get them exposure in Direct mail, E-newsletter marketing and even television.

INCENTIVE SYSTEM PROS AND CONS

Demographics are probably the most important factor to look at when considering an incentive system partnership. An incentive system model is particularly attractive to lower-income communities because it offers coupons and other economic incentives to recycle. By rewarding households with coupons for groceries or services, an incentive system is having a direct positive impact on family budgets. Therefore, recycling becomes something households participate in for financial assistance, rather than altruistic reasons. The following is a partial listing of the pros and cons of incentive systems.[2]

Pros

- Incentive-based program rewards recycling participation and builds good recycling habits
- Public awareness and participation in recycling rises
- Substantial rise in material volumes
- Data on the effectiveness of existing and proposed waste collection routes and strategies is collected
- Opportunity to modernize or upgrade the waste collection and recycling infrastructure

Cons

- System rewards consumption, not waste reduction
- Program may be a poor fit in communities with already high recycling participation
- Success relies on the participation of national and local businesses and retailers
- Upgrade costs could be prohibitively expensive for communities and smaller haulers if not adequately negotiated with Service Provider
- Program not cost effective in areas with low-cost disposal

PROCESSING OPTIONS

Choices pertaining to both sorting technologies and overall processing choices are predominantly driven by curbside collection systems. Substantial improvement in processing capability and efficiency has been experienced in the past 5-10 years. Beyond the initial use of magnets to capture ferrous metals at an efficient rate, and eddy currents to separate and capture aluminum from the sort, more sophisticated equipment and reconfiguration of the sorting systems has resulted in higher recovery rates, greater throughput, and less contamination to meet market standards.

The number of recyclable materials has increased as the ability of secondary and manufacturing industries to convert post-consumer packaging into marketable products has grown. Subsequently, the market demand for the greater variety and volume of materials has driven MRF's to seek equipment that enable them to efficiently recover an increased array of post-consumer plastics and fiber. The processes must also be designed to increase the volumes or tons per day, to justify the investment in such equipment or systems.

MRF's and equipment manufacturers, to remain competitive and derive the greatest value from the collected material, continue to improve the ability of the sorting methodology and performance standards. Systems are configured to provide screening of non-recyclable materials and contaminants from a particular recyclable material to yield a higher value end-of-sort product. Optical sorting technologies have advanced to enable

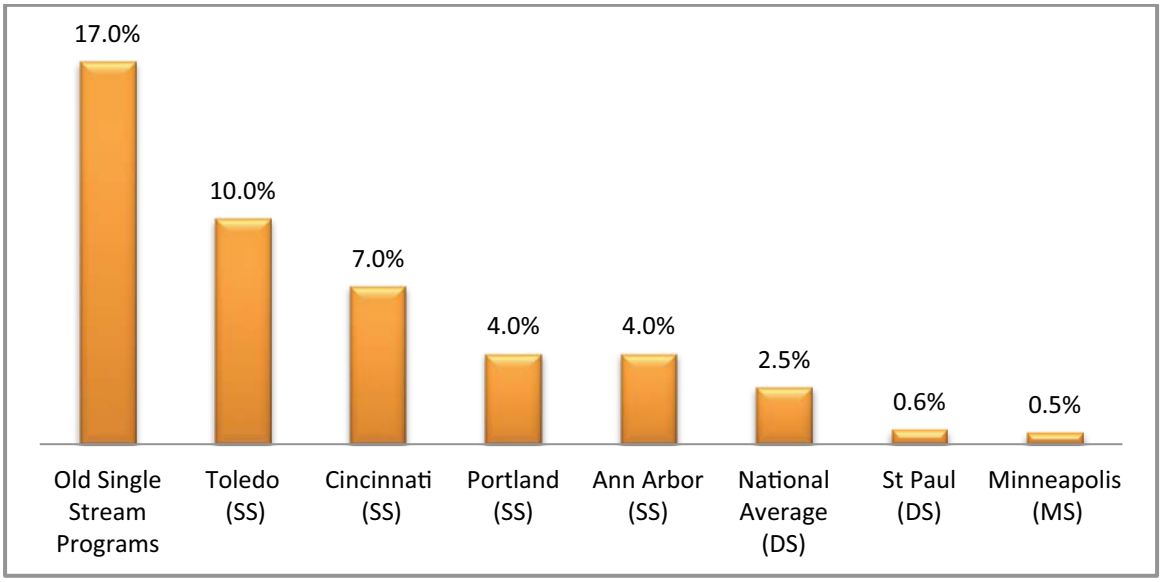
[2] *Resource Recycling Magazine*, October, 2009

efficient and broader range of sorting plastics and fiber cartons that results in an increased variety of accepted materials for recycling at a higher marketable value.

Residual rates are an indicator of the success of the sorting systems and the recycling collection program. Residual rates in both dual sort and single sort sorting systems have declined over the years, as evidenced in the Table below. Whether dual sort or single sort, the ability to recover everything that is recyclable or marketable and to remove waste that cannot be recycled is a key factor in determining the type of recycling program provided. It is also a key measurable in determining overall recycling program success or failure.

A study[3] conducted for the MPCA by Tim Goodman & Associates to examine the issue of single-stream and dual-stream recycling, focusing specifically on the processing of collected materials and the marketing of those materials to end-markets. A key finding of that study stated: "The amount of processing residuals (including mixed, broken glass) generated at the single-stream facilities serving the Minneapolis/St. Paul metro area varies significantly from approximately 2% of throughput up to 17% of throughput".

FIGURE 3: MATERIAL RECOVERY FACILITY (MRF) RESIDUAL RATE*



* SS - Single Sort, DS - Dual Sort, MS - Multi Sort

Quality control remains a critical element in MRF recovery. At various points in the recovery process, testing or checking of the commodity destined for markets can result in increased value to the commodity. The community can also play a role in helping to increase the value of materials collected. To ensure quality standards, communities can require contracted MRF's to report volumes and percentages of recovered materials by type, including residue rates; set minimum standards of recovery and residue, and the volume of materials sold as various grades in the recycling markets. The Goodman study recommended certification process be applied to MRFs. MRFs should be required to report certain operational data for monitoring purposes. This information should include at a minimum:

- Amounts and types of recyclables delivered to the facility;
- Amounts and composition of processing residuals;

[3] *Single-Stream and Dual-Stream Recycling: Comparative Impacts of Commingled Recyclables Processing*, Prepared For the Minnesota Pollution Control Agency Tim Goodman & Associates, January 20, 2006

- Amounts and types of materials processed and marketed on an annual basis; and
- Amounts and types of materials downgraded or rejected by markets.

Residual rates at the MRF can also be improved by education. As recycling participation increases, it is important to provide direct, simple and positive education about what can be recycled. Consistent, accessible, user-friendly education about what can be recycled makes an impact on the participants' participation to place the materials that are accepted in the recycling container. Even with the most efficient system for sorting materials, if an item that is not included in the recycling program is incorrectly placed in a recycling bin, it must be treated as residual at the MRF.

SECONDARY MARKETS

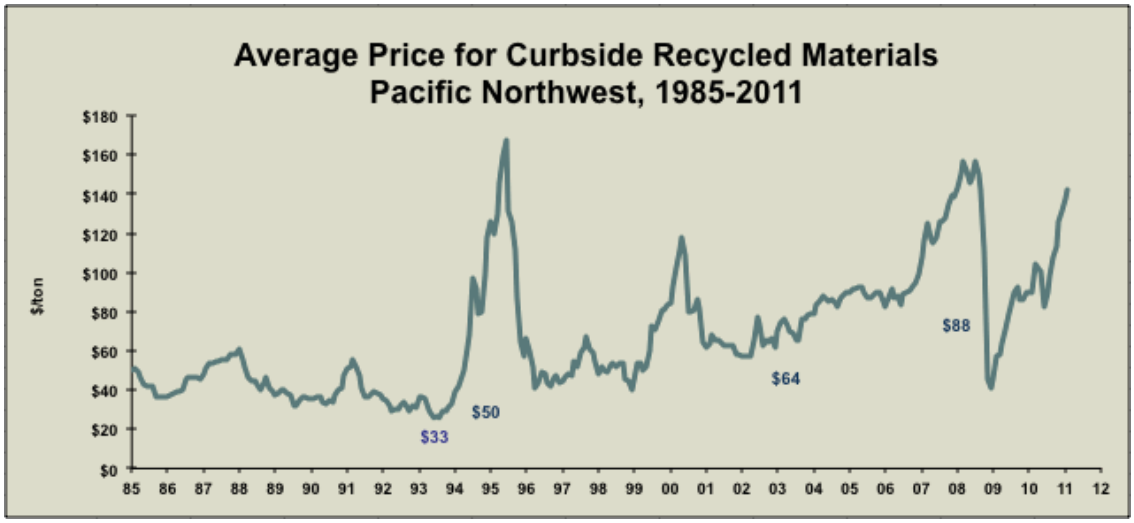
Manufacturing techniques using post-consumer materials also have kept pace with technology and knowledge of the materials sorts. Mills have improved their equipment and systems to predict and adapt to a degree of contamination and to capture contaminants to minimize damage to equipment and maintain quality product standards.

End markets for even more materials, especially the #3-#7 plastics, has provided opportunities for MRF's to increase their list of accepted materials and collected volumes. In fact, the capabilities of both dual and single sort collection programs to easily add materials types to their collection programs has led to the expansion of recycling programs nationwide. Without these inherent flexibilities, the successful recycling of cartons, juice boxes, textiles, boxboard, and exotic plastics (#3 - #7) would not have grown as quickly over the last five to ten years.

MARKETS AND REVENUE FOR MATERIALS

All materials collected and ultimately processed in a recycling program are considered commodities. This means that in spite of market demand fluctuations and associated price increases or decreases, the total collected tonnages must yield a profit to maintain a healthy, stable recycling program. In reviewing the Market Trends Data, the market demand and commodity prices for fiber, plastics, aluminum and steel have remained strong to stable. Two brief periods in the early 1990's and mid 2000's have seen brief price tumbles. But recycled commodity price rebounds have been quick and over time have shown an almost universal strengthening. The commodity revenues associated with these materials have over time provided the financial foundation for most recycling programs, whether publicly or privately sponsored.

FIGURE 4: MARKET TREND DATA



Communities can choose to request MRF's to share in the market value of materials that are sold, as contracts are prepared. This is a typical practice when separate contracts are awarded for collection and for processing and marketing of materials. A revenue sharing arrangement provides an incentive for both the MRF to maintain high quality and market standards and for the community to encourage residents to participate in the recycling program and educate residents how materials should be set out to maximize the benefit of the program.

A market share arrangement generally includes an established floor price, which guarantees a minimum price per ton paid to the community for materials brought to the MRF. The floor price can be fixed based on the market value of a select number of items or the total mix of recyclable materials collected. When the market value of the recyclable tonnages exceeds the established floor price, the community and the MRF share in the value of the sold commodities, based upon an established percentage split.

As an example: Cincinnati has a market share arrangement with their MRF, operated by Rumpke, which provides a floor price of $85/ton. If the revenue from sale of the materials exceeds $85/ton, 50% of the revenue above $85/ton is shared with the city.

GENERAL DISCUSSION OF DUAL-SORT RECYCLING

Background on Dual-Sort

Dual-sort recycling is a collection and processing system where mixed bottles and cans are collected in one compartment and mixed fiber is collected in another compartment. For many years and until recently, this technology has been the default choice for large-scale residential recycling operations in the US.

As more programs recognized the high cost of paying drivers to sort material at the curb, efforts focused on finding a collection method that did not require sorting at the curb. Programs found that residents responded well to being asked to sort materials into two containers. These two containers could be dumped into the collection vehicles with no curb-sort. By 1990, most new recycling facilities were being designed with dual-sort sorting capabilities.

The reduced cost of dual-sort curbside collection was traded off against the increased cost of central sorting. An incentive for doing this was the increased ability to accept a wider range of recyclable materials and still produce marketable products from the collected materials. Many dual-sort facilities were designed with the ability to sort to more than 20 products. A typical dual-sort program collects and processes at least the following list of materials:

- Fiber sort
  - Newspaper
  - Cardboard
  - Paper bags (depending on local markets this might be baled with cardboard)
  - Magazines (depending on local markets this might be baled with news or mixed paper)
  - Junk mail (depending on local markets this might be baled with news or mixed paper)
  - Boxboard (depending on local markets this might be baled with news or mixed paper)
- Container sort
  - Clear glass
  - Colored glass (Green & Brown) (in many areas, glass is no longer color sorted at the MRF)
  - Steel cans
  - Aluminum cans
  - Natural HDPE plastic bottles
  - Colored HDPE bottles
  - PET bottles

A number of dual-sort programs have also added the following materials:

- Fiber sort
  - Shredded paper (depending on local markets this might be baled with SOP or mixed paper)
  - White office paper (SWL) (depending on local markets this might be baled with SOP)
  - Mixed office paper (SOP)
- Container sort
  - Colored PET bottles (only common in a few regions)

- Mixed plastic containers (small food tubs, clamshells, trays, etc.)
- Large rigid plastics (lawn furniture, buckets, large plastic toys)
- Cartons (aseptic and milk & juice gable-top)
- Junk metal (some restrictions on size and material need to apply)
- Plastic film (plastic bags, and stretch & shrink wrap)

The junk metals, plastic film and large rigid plastics are challenging to handle in a cost effective manner, so these materials are often directed to a drop-off collection that compliments curbside collection.

Dual-Sort Scale of Operations

Dual-sort systems have been built to operate in sizes ranging from less than 2,500 tons per year (tpy) to over 200,000 tpy. In smaller facilities, nearly all sorting is done manually. Many of these smaller facilities have only one sorting line that is used alternately for containers and fiber. Larger facilities that require more throughputs have specialized sorting lines that utilize staff more efficiently. Larger facilities also add mechanical separation technologies such as:

- Cardboard (OCC) screen to separate large cardboard from other fiber
- Magnet to remove steel cans from other bottles and cans
- Fines Removal Screen or Glass Breaker to remove broken glass and dirt from bottles and cans
- Density Separator to remove glass from lighter bottles and cans (if no glass breaker)
- Eddy Current Separator (ECS) to separate aluminum from other containers
- Optical Sort to sort plastics by resin type or to sort other optically identifiable materials such as cartons

Dual-Sort Sequence of Operation

A typical single sort processing facility has two sort lines and one or more balers. Eureka Recycling is an example of a medium-large dual-sort processing facility. See Appendix III for s diagram of a Dual Sort Process Flow Diagram. A Dual Sort facility consists of the following processing sequences.

Fiber Sort Line:

- Mixed fiber is dumped from the collection vehicle onto the tipping floor
- A large loader pushes materials up and then loads them onto an in-floor metering conveyor as sorting progresses
- An inclined conveyor carries mixed fiber up to the pre-sort conveyor where sorting staff removes trash and oversized items
- Cleaned fiber falls onto the cardboard (OCC) screen. Smaller fiber passes through the screen and OCC is conveyed off the end of the screen and piled on the floor where a loader can later load sorted OCC onto the baler feed conveyor.
- Smaller fiber is conveyed to the main sort conveyor where staff picks off small OCC, trash and other products. Cleaned newspaper (ONP) drops off the end of the sort conveyor onto a conveyor that feeds to a baler.

Container Sort Line:

- Containers are dumped from the collection vehicle onto the tipping floor
- A large loader pushes materials up and then loads them onto an in-floor metering conveyor as sorting progresses

- An inclined conveyor carries mixed fiber up to the pre-sort conveyor where sorting staff removes fiber products, trash, and oversized items
- Material passes under an overhead self-cleaning magnet that removes steel (includes tin plated) cans and other ferrous metal to a conveyor that leads to a storage bin
- The rest of the bottles and cans pass over a roll-screen that drops out small glass, dirt, and other fines
- The overs are fed to a density separator that pulls the plastics, aluminum and cartons (if present) separate from the remaining glass. The glass continues to a manual glass sort line where the glass can be manually color sorted
- Aluminum is sorted from the light fraction using and Eddy Current Separator (ECS). The aluminum is conveyed to a storage bin by a blower/duct system.
- The remaining light fraction is conveyed to an elevated sort line where staff sorts remaining plastics and cartons

GENERAL DISCUSSION OF SINGLE-SORT RECYCLING

Background on Single-Sort

Single-sort recycling is a collection and processing system where all bottles and cans are combined with all fiber in one collection container. This technology has been a significant part of residential recycling in the US for approximately 10 years. The technology for single-sort processing is still evolving rapidly. The appeal of single-sort recycling comes from several factors:

- Residents place all recyclables in one container. This is often a cart with a lid that can be stored outside without other cover. In most communities this makes recycling easier for residents and provides residents with more recycling container capacity
- Most single-sort rollouts have resulted in significant increases in recycling collection volumes. In many areas where Recycle Bank or other incentive programs have been included, the increases have been dramatic.
- Adding new materials is very easy for residents because they just add the material to the one container. There is no confusion in what bin to place a new recyclable.
- Collection costs are usually less than for other curbside recycling technologies. This is true whether the driver must dump tubs, dump carts with a mechanical cart dumper or if the driver can sit in the cab and dump carts with an automated robotic arm. Because there is only one container, each stop takes less time than dumping the same container type with multiple containers. Less time at a stop means a driver can pick up at more stops in a day.
- Automated cart dumping usually results in significant reduction of workers compensation claims, since most carts can be dumped without manual handling.
- When using automated collection vehicles, identical collection vehicles can often be used for recyclables, organics and trash. Having all the same vehicle requirements simplifies fleet service and parts inventory and allows rededication of trucks with just a change in signage or paint.
- The collection vehicle needs only one compartment for recyclables, which means compaction is common and usually more stops can be made before returning to empty.
- Multiple compartment trucks can collect trash and organic waste with recyclables where a single provider offers two or three services. Combined collection reduces truck traffic on any one street and reduces total fuel consumption where alternate week service is not acceptable.
- Collected recyclables can be hauled long distances cost effectively. All recyclables can be tipped in one pile and loaded into a single transfer trailer. This allows a single processing facility to

competitively serve residents in large radius (in some cases over 200 miles). Hub and spoke regional recycling service is becoming practical in many underserved parts of the US as a result of simplified transfer.

- Except for color sorted glass and plastic film, recent large single-sort facilities are able to efficiently sort recyclables and produce quality products with comparable or less labor cost than in a similarly sized dual-sort facility.
- Many recent single-sort facilities incorporate secondary fiber recovery and other scavenging technologies are able to achieve residue rates approaching that of dual-sort facilities

Early Single-Sort Problems

Early single-sort processing facilities exhibited some problems. The two most significant problems are described below:

- The most cited problem is high residue rates. High residue rates were common in early facilities. These high rates resulted from a combination of unrefined processing technologies, loss of driver quality control and poor education of residents. Because fiber and containers are mixed, reclaiming small recyclables from residuals is more complex than for the same target materials in dual- sort facilities. Shredded paper, fine glass, plastic film and caps and lids are among the most challenging materials to recover. Newer facilities that are designed with the capability to reduce residue and with an operator that committed low residue can achieve low residue rates.
- The other common problem for early single-sort facilities was poor product quality. The main product quality issues have been with glass and lids in fiber products and glass in plastic products. Also, early screens were not able to separate newspaper from other paper grades very well. Newer separation screens can produce products that compete with the best dual sort product quality. Newer screen especially when combined with a glass breaker at the front end of the system are able to produce products rivaling that of dual-sort facilities

Challenges

Single-sort recycling does not solve all problems for recyclers. A number of challenges remain for a single-sort facility operator.

- Single-sort processing equipment is more sensitive to certain materials than most dual-sort processing lines. In particular, plastic film, garden hoses, rope, cords, wire, strapping and chains quickly become wrapped around screen shafts. Allowing these materials to reach the separation screens can result and reduced screen efficiency, lost production time and in some cases, the need for costly repairs.
- Most single-sort facilities often operate at a higher residual rate than comparably sized dual-sort facilities. With good education of residents, sufficient pre-sort effort, modern reclaim features and manual reclaim from the residual sort, residuals of less than five percent are common. Lower rates are possible with additional picking staff and management committed to low residuals. This extra effort can in some cases increase operating cost.
- Single-sort processing equipment is more costly to purchase than that of a comparably sized dual-sort facility. This is especially true for smaller facilities where single-sort equipment does not scale well. When significant quantities of mechanized sorting are added to a dual-sort facility, the capital cost of the dual-sort facility may approach that of the single-sort facility.
- Single-sort facilities require more maintenance and more expensive maintenance than dual-sort facilities. More equipment needs maintenance, but also, a higher level of skill is needed to perform

some of the maintenance. Hundreds of screen discs must be changed every 12-24 months and these typically cost $40 each.

Improved Technologies

Most recent single-sort processing facilities incorporate a number of improved technologies that improve operating efficiency, product quality and reduce residue as compared to earlier facilities. While these add to the facility capital cost, an acceptable return on investment can be demonstrated when the features are applied appropriately. A partial list of improvements follows:

- Front end metering to keep the flow of materials very close to the optimum capability of the line for the mix being fed and to simplify line loading and allow loader operator to perform other tasks.
- Large presort to remove trash, oversize materials and materials that might wrap on screen shafts, and to allow recycling of large rigid plastics and scrap metals
- News and Mixed Paper screens have been much improved, reducing the amount of post sort needed to produce marketable products, and at the same time providing a cleaner sort to the container line.
- Where significant volumes of cardboard are present sort, adding an OCC screen at front end to eliminate most manual sorting of OCC. This makes other screens more effective and reduces staffing requirements at presort and at fiber post sorts.
- Glass removal at front end to get glass out of other products and to prolong the life of equipment.
- Glass cleanup systems to improve glass quality and in some facilities to reclaim small (shredded) fiber for recycling
- Fiber reclaim from mixed container sort to reduce residue and recycle more fiber
- Bottle and can reclaim conveyors from fiber post sort lines
- Optical plastic sorting to reduce labor needs, increase throughput and efficiency and sort grades that humans cannot differentiate visually (ex: PLA vs. PET). Optical sorting can be used for PET, NHDPE, colored HDPE, PLA, #3-7 (or grades within), aseptic cartons, milk and juice cartons and various combinations of these. Optical sorters can also be used to color sorts where the markets demand this effort (ex: green PET or light and dark CHDPE). The quality of sort and reliability of this equipment has improved dramatically in recent years. Also, dual-sort optical sorters perform well in some applications to sort two products from the sort at one time.

While most of the above technologies can be applied to dual-sort systems, most dual-sort MRFs are not operating at a scale to justify these solutions. Single-sort programs are capable of collecting all of the materials that can be collected in dual-sort systems. The list of materials in the Dual-Sort discussion above also applies here.

Because some materials will clog or jam the mechanical sorting equipment, additional efforts may be needed at the pre-sort to remove these materials. Examples of materials that generally need to be removed at pre-sort include large rigid plastic, junk metal and plastic film. These materials are manually sorted from the sort at the pre-sort station. This can be costly for plastic film where a good deal of hand motion is required to sort just one pound of material. Missed plastic film wraps on the screen shafts and must be cut off frequently. These materials that cannot be easily sorted mechanically are often directed to drop-off collections that take these materials and other difficult to handle recyclables.

Single-Sort Scale of Operation

Historically the throughput sweet spot for single-sort facilities has been 15 ton per hour (tph) or 30,000 tons per year (tpy) or greater. This was based on the early screens that separated fiber from containers performing well at 15 tons per hour. The screens could be run at lower rates, but manual sorting staff requirements did not decrease much because of the sort locations that must be staffed, making smaller facilities proportionately more costly to operate. Some facilities were built in the 8 tph size range, using smaller or less advanced screen designs, mostly to serve isolated populations, large rural areas or where recycling rates are low. These lower throughput facilities could not compete economically with larger facilities where sufficient volume of recyclables is available.

Recent designs with a single sort line appear to perform well in the 15-35 tph-size ranges. At throughputs below 35 tph, increased capacity is obtained through increase in size of separation equipment and increase in the number of separation stages rather than through parallel equipment. The primary advantage of this approach is that little additional staff is required to increase throughput. As a bonus, the additional separation stages also have the potential of providing better separation quality and automated production of additional fiber grades.

Most equipment designers choose to split the material sort after the OCC screen into two lines when processing 35 tph or more rather than build huge components to handle it all as one sort. This allows for a loading/metering station, a single large presort and a single OCC screen. These split systems have been designed to operate at more than 50 tons per hour. Usually, containers are recombined into a single sort for optical sorting.

Facilities sized to process 50,000 tons or more per year usually justify optical sorters for PET and NHDPE. A number of facilities in this size range are also adding optical sort for CHDPE, #3-7 plastics and cartons. Many larger facilities add more optical and mechanical sorting rather than increasing staff.

A number of facilities have been built to process more than 200,000 tons per year. Most recent large facilities use optical sorters for most plastics. A few MRFs use optical sorters to post sort mixed fiber. These larger facilities are usually set up to receive transfer trailers and to serve a large geographical area. In the Chicago area, several large MRFs compete, drawing materials from five to seven states.

Sequence of Operation

The separation technologies vary somewhat from one manufacturer to another, but with a few exceptions there is general agreement on the process sequence. The two areas where design sequences vary significantly are the place and method of glass removal and the place and method of small fiber recovery. See Appendix IV for a diagram of the Single Sort Process Flow Diagram. The following describes a typical single-sort equipment sequence:

- *Loading hopper* – This is usually loaded from the tipping floor by a large wheel loader
- Metering (either metering drum from hopper or metering drum over inclined conveyor following hopper with optical feedback control)
- Presort – A large horizontal conveyor with picking stations for materials such as trash, large rigid plastic, junk metal, any materials that might wrap screen shafts. If no OCC screen follows, large OCC is picked here. If plastic film is collected, overhead suction tubes may be provided for film collection from sorters' hands.
- OCC screen – Large OCC is removed (not needed in facilities where little OCC shows up in single-sort in-feed)
- Most facilities provide a an OCC post-sort station that may or may not be staffed

- Second presort – Needed where lots of large OCC is delivered in single-sort materials because it is difficult to see under the large OCC
- Glass removal – This can be done under OCC screen (BHS) or under a scalping screen following OCC screen (CP). This is often accomplished with a multi-stage all-metal roll-screen designed to break and screen glass from other materials. Glass is usually directed to a glass clean up system to remove most non-glass materials before the glass is stacked in a bunker.
- The materials that pass through the OCC screen but not the glass breaker are fed to a news screen that separates newspaper from bottles and cans with smaller fiber. The ONP goes to a post sort station where brown paper/OCC, contaminants and out-throw are sorted to achieve the required market specification.
- The bottles and cans with smaller fiber (unders) from the news screen pass to the next screen which separates mixed paper from the mixed bottles and cans. The mixed paper goes to a post sort station where bottles and cans, contaminants and newspaper that was not captures by the news screen are manually sorted to appropriate bins or conveyors.
- The small paper that comes out with the bottles and cans from the mixed paper screen is recaptured either as part of the mixed paper screen operation or as a secondary process (CP uses air drum separators – ADS). Small paper is fed to the mixed paper post sort.
- The bottles and cans are conveyed to the container sort section. Steel cans are pulled off with an overhead magnet.
- Optical sorters remove PET, NHDPE and possibly other materials (CHDPE, #3-7, cartons). Post sort manual inspection stations allow sorting materials missed by optical sorters. If PETG must be kept separate from PETE, this is usually accomplished manually at the PET post sort station.
- Materials not sorted by optical sorters are manually sorted into appropriate bins
- If aluminum is left on the line, an eddy current separator (ECS) captures the aluminum. Post sort stations can be staffed to capture missed aluminum and pick recyclables from residue. Some facilities manually sort foil items such as pie tins, but leave cans on conveyor for ECS, either to bale these materials separately or because some ECS units do not sort foil well.
- Manual residuals sorting of recyclables missed on line. This position is built in most new facilities, but often not staffed.
- All sorted materials are stored in bunkers and bins and fed to one or more balers as bins fill.

ADDING MATERIALS TO THE RECYCLING SORT

A number of MRFs recycle several materials that Minneapolis does not yet accept.

- Metal recycling could also be expanded.
- Minneapolis does collect most fiber materials. Depending on local markets, Minneapolis may be able to recycle other poly-coated papers with cartons or as a separate fiber grade
- While markets for post consumer plastics other than #1 (PET) and #2 (HDPE) bottles have not yet matured, Minneapolis could substantially increase plastic recycling. Most processors are having no problem marketing the plastics they receive as long as the material is clean. The three most common inputs are plastic film and large rigid plastics.

Each of these possible new materials is discussed in some detail in the following sections.

METALS

Many curbside collection programs include junk metals. In dual-sort recycling these materials are collected with containers and pulled out at the pre-sort station. In single-sort recycling the junk metals are pulled out at the main pre-sort station. The challenge with junk metals is defining what is and is not accepted and making sure residents are aware of the acceptable limits. In order for the collected material, to have good value to the recycler, it needs to be clear that toaster ovens and microwaves are not accepted because a large portion of them is not metal. Usually automobile parts are excluded, but items such as pots and pans are encouraged. ER could add junk metals if in expanding its container pre-sort a chutes and a bunker are added for this material. If ER moves to single-sort collection, similarly, a place for this material could be included in the pre-sort. Amounts collected vary widely depending on restriction on materials and other entities that accept metals in the area. RRS Recommends that ER consider recycling junk metals.

POLY-COATED FIBER

Poly-coated fiber is used to package many refrigerated and frozen food products as well as used for manufacture of paper cups. Some packages are coated on one side only, while others are coated on both sides. Single coated packages may have printing on the fiber, where as on double coated fiber, the ink is usually on the poly. These packages also contain varying amounts of wet strength resin in the fiber. Accordingly, not all mills that accept cartons can accept these materials. Where these materials can be sold with the cartons, the volume of poly-coated fiber can typically be doubled over the volume of cartons (aseptic plus gable-top) alone. Poly coated packaging presents a challenge for collection and separation. In dual-sort collection, it is usually collected with containers. This can be confusing to residents. In single-sort processing, flattened packages may be mechanically sorted to mixed paper, while 3-D packages will be sorted to containers. Optical sorters can readily identify/sort poly-coated fiber on the container line, but manual sorting would be required to pull this material from the mixed paper. RRS recommends that ER explore marketing opportunities for this material. If a range of poly-coated fiber can be mixed with cartons and sold at the same price, RRS recommends that ER explore the feasibility of adding this material. In the existing system, no new hardware would be needed.

PLASTIC FILM

Plastic film can include plastic shopping and produce bags, industrial shrink-wrap, industrial stretch wrap and a variety of other bags and wraps. Plastic films of low-density polyethylene (LDPE), medium density polyethylene (MDPE), high-density polyethylene and polypropylene are common. All of these plastics belong to the polyolefin family. Most industrial shrink and stretch wraps are also polyolefin. Most MRFs that receive plastic film bale it

all together. Mixed polyolefin is used in making plastic lumber and other products that do not require specific melt and flow properties. If specific resins can be baled separately, the plastic film has a much higher value and the plastic be recycled into higher end products.

In areas where a large number of boats are shrink-wrapped for winter storage, having a bunker designated to stockpile this material every spring can be profitable. Distribution centers that restack pallets are often a significant year-round source of natural colored shrink and stretch wrap. If ER can encourage haulers to bring post-industrial clean plastic film to the MRF, ER can make money baling and selling this product. The price for clean post-industrial wrap varies, but $200-300/ton is common in some areas.

Residential plastic film is primarily plastic bags. Most grocery shopping bags are HDPE and most produce and bread bags are LDPE, however, there is no standard. Most manufacturers of recycled content bags need material sorted by resin type. Plastic film is difficult to sort manually, mechanically or optically, so making shopping bags from shopping bags is not generally cost effective. The biggest problem in collection is making sure that bags are clean. Significant food contamination is a problem for nearly all buyers.

If plastic film is collected curbside, some means of consolidation is needed to keep bags from blowing around and to allow efficient sorting at the MRF. One of the most effective methods thus far observed is known as "Bag-the-Bag". In this approach, residents are instructed to stuff all bags in one outer bag and to tie the outer bag shut when the bag is full. The full bag is then placed at the curb with other recyclables.

If collecting dual-sort, residents can be instructed to place the bag with either containers or fiber. Fiber is usually the preferred option, because bags can be sorted to a bunker either at pre-sort or at the main sort. If included with containers, bags must be picked at the pre-sort and the likelihood of contamination with broken glass is much higher. If collected in a single-sort program, bags must be picked at the pre-sort. Overhead suction tubes are often used to convey bags from multiple pick points to a common bunker. Because it takes from 200,000 to over 1,000,000 bags to make a bale, picking individual bags is not practical unless labor cost is very low. As a percentage of the total recycling sort, plastic bags are a small percentage. In programs aggressively collecting plastic bags, they can make up as much as 0.5% of the recycling sort. The value of this material varies wildly from $40-200/ton depending on product quality and available markets.

Based on programs that have been observed thus far, RRS does not recommend that ER collect bags curbside. The challenge is getting residents to keep bags clean and consolidate them for efficient sorting. While residents are generally eager to add bags to their recycling, this can be a costly addition to the bin without ascertaining that residents will prepare the bags properly.

LARGE RIGID PLASTICS

Large Rigid Plastic usually refers to a wide variety of large molded objects. Lawn furniture, riding toys, play structures, buckets, large tubs, and a number of other larger molded plastic objects are typically included. The objects are mostly made from HDPE and PP. Because the pieces are large, hand sorting at secondary processor into specific resins is even practical in the US, though much of this material is sold off shore. This material is easily collected at drop-off stations, and is collected in many curbside programs. When collected single-sort this material is pulled out manually at the pre-sort. In dual-sort collection, this material is almost always collected in the container sort.

The primary problem with large rigid plastics is the physical size of the object. Some programs limit the size of the largest piece. Others require that all objects fit in the collection bin or cart. Collection works best if the truck can compact the object, to avoid having the compartment on the truck fill prematurely.

OPIMIZING SORTING CHOICES

MRF operators can usually select how the fiber in the feedstock gets divided in to end products. Where all sorting is a manual operation, the operator can choose to split the sort into as many products as he/she has bins to sort into. In more mechanized single-sort systems, typically two or three fiber sorts are separated mechanically, but the operator still has the option to further sort these sorts manually if the facility was designed with sufficient space to do so.

The number of products produced is a choice of the operator, based on trade-offs among several factors including, marketability, price, cost of production and environmental values. For example, white office paper can be extracted from a mixed residential sort as part of ONP, part of a mixed paper grade, part of sorted office paper (SOP), or sorted white ledger (SWL). While SWL has the highest value and the highest potential end use, the cost of sorting this small fraction of the fiber may exceed the resulting value increase as compared to leaving the material in ONP or some other more easily sorted grade. Even as a purely environmental decision, the highest end use may not prove to be the best choice in life cycle analysis (LCA).

Another factor in selecting what products to produce is the evolution of the consuming mills. Over time, mills have become more tolerant of mixed grades. In 1980, mills making new newsprint from ONP wanted all colored printing and glossy paper removed from the mix. By 1985 all inserts delivered with the papers were an acceptable part of the grade. By 1990, many mills were accepting junk mail and magazines with the ONP. Many mills are now able to produce a better newsprint product with these other grades included in the feedstock than without the other grades present.

When single-sort (SS) MRFs first came on the scene, many mills found that the ONP was not meeting their input standards. While recent single-sort MRFs are now able to produce very clean ONP, mills have also adapted to work well with a wider range of feedstock. Because most of the post consumer ONP is now coming from SS MRFs and because in the future more and more ONP will come from SS MRFs, mills have little incentive to depend on ONP from dual-sort (DS) facilities. Few mills can afford to refuse ONP from SS MRF's and few if any offer a premium price based on origin. Some mills will pay a premium based on long-term consistent high quality, regardless of the MRF technology.

Touring a number of MRFs would demonstrate to Minneapolis staff that the quality of the ONP and the quality of most other products is a function of the resources applied to sorting rather than whether the facility is set up as SS or DS. In short, product quality is more dependent on operator staffing decisions than on technology. This also applies to recyclables leaving the facility as residue or as out-throw in other products. Technology does however play a major role in improving efficiency of sorting operations when used wisely.

FINDINGS AND RECOMMENDATIONS

Over the last decade recycling processing technologies have evolved rapidly and continue to evolve. Over that same decade, single-sort collection and processing has grown from a questionable experiment to the primary approach for large recycling programs. The following points stress that single-sort now dominates residential recycling in the US and is here to stay.

- In the last five years, few large dual-sort MRFs have been built in the US.
- Most large MRFs built in the last few years in the US were built to process single-sort recyclables.
- Most large dual-sort MRFs have been converted to single-sort operation, or have been replaced by newer single-sort MRFs near by.
- Significantly more than half of all residential recyclables collected in the US are now collected as single-sort
- End markets have gone from questioning the consumption of materials from single-sort MRFs to welcoming those materials and adapting their processes, when needed
- Single-sort processing equipment, while still costly, has become very functional and reliable
- Most municipalities see a bump in collection volumes that significantly out weighs any increases in residuals when converting to single-sort

Currently, there are many examples of programs that demonstrate that low residual rates are possible, high product quality is easily achieved and net recycling rates can be increased with a single-sort program.

Dual-sort recycling remains technically viable. When you consider that the market trend to offer single-sort processing and that placing recyclables all in one container is attractive to most residents, it is clear that Minneapolis needs to seriously consider switching to single-sort collection.

Single-sort collection and processing would also allow consideration of transferring recyclables from milt-family locations should Minneapolis be interested in offering recycling services in currently under-served areas. Cart based collection programs are also consistent with the development of an organics collection program.

This report does not provide definitive cost comparisons. Doing so will not be practical until Minneapolis makes some decisions on changes to the current approach to the collection of recyclable materials. Firm cost numbers can be developed by asking vendors for preliminary proposals at any point that Minneapolis has made a decision on a proposed direction to pursue.

The State of Minnesota and Hennepin County are moving forward with a new waste reduction goal that requires changes to the city's current recycling collection and processing system. Many communities have tested and succeeded with converting to dual-sort and single-sort collection programs and it is recommended that the City move to one of these two collection systems with single sort system offering the highest recovery rate at the lowest cost.

Key Points from Recycling Program Study

The study findings, summarized below, are based on information collected from the city's pilot programs and from the experiences of other cities, and from focus group meetings held with current Solid Waste and Recycling customers. The project evaluated single-sort and dual-sort collection for both weekly and biweekly collection.

Recovery

1. A single-sort system is projected to increase materials quantity recovered by 60% and the Minneapolis recycling rate increases from 18.1% to 32% (based on case studies such as Ann Arbor and Portland).
2. A dual-sort system is projected to increase materials quantity recovered by 36% and the Minneapolis recycling rate increases from 18.1% to 25% (based on case studies such as Ann Arbor and Portland).

Processing

1. The majority of local recycling centers - Material Recovery Facilities (MRF's) - are well equipped to handle single sort collection.
2. Preliminary research indicates no difference in market revenues – single vs. dual in local MRF's.

Operations and Operational Costs

1. Collection time for single-sort is less than dual-sort and there is no need to come off route when one compartment fills before the other.
2. A single-sort recycling system preserves space for a possible third cart for comingled yard waste and organics.
3. A semi-automated rear load truck (such as currently used for garbage collection), with 2 staff per truck, best serves alley-based collections. This is the same system that is currently used for garbage collection.
4. Single-sort collection allows for utilization of a similar truck fleet to current rear load packers, resulting in a more cost-effective fleet than adding a completely new type of vehicle for recycling collection.

Capital Costs

1. Dual-sort collection requires an additional truck cost of $28,000 more than single sort truck due to split body packers.
2. Cart cost for single sort (1 per unit @$65) is estimated at $6,800,000.
   Truck Cost (8 trucks) for a bi-weekly single sort collection program is $1,976,000.
3. Cart cost for dual sort (2 per unit @$50) is estimated at $10,500,000.
   Truck Cost (9 trucks) for a bi-weekly, dual sort collection program is $2,475,000.

Overall Program Costs

Table 17: Projected Net Recycling Costs

Options	Current Multi-Sort Baseline	Single Sort Semi Auto Biweekly	Dual Sort Semi Auto Biweekly
City Collection	($1,694,275)	($1,666,070)	($1,831,460)
MRI Collection	($1,694,593)	($1,666,371)	($1,831,791)
Total Collection Cost	($3,388,868)	($3,332,441)	($3,663,251)
Material Revenue	$1,640,937	$1,280,504	$1,173,796
Net Recycling Costs including Revenue	**($1,747,931)**	**($2,051,937)**	**($2,489,455)**
Value of MSW Diverted	$847,231	$1,335,318	$1,224,041
Net City Recycling Costs (Annual Cost -MSW Diverted	($900,701)	($716,619)	($1,265,414)

*Assumes a Processing cost = $70.00
Current Processing Cost = $24.04

The Net Recycling Costs are the lowest for the Single Sort Semi Automated Bi-weekly collection program by approximately 20% below current net cost while achieving a 32% recycling rate. The Dual Sort Bi-weekly program has a net cost of approximately 65% higher then the current multi-sort program and achieves a 25% recovery rate. A ten percent increase in the quantity of material collected in the single sort program achieves a 35% recycling rate with a net cost that is 40% lower then the current program. A ten percent increase in the quantity of material collected in the dual sort program achieves a 28.5% recycling rate with a net cost that is 40% higher then the current program.

Single-sort collection and processing also allow consideration of transferring recyclables from milt-family locations should Minneapolis be interested in offering recycling services in currently under-served areas. Single sort collection programs are more compatible with the development of a yard waste and organics collection program that would require another cart.

Although dual-sort recycling remains technically viable, when you consider that the market trend is toward single-sort processing and that placing recyclables all in one container, which is the most convenient to most residents, it is clear that Minneapolis should consider switching to single-sort collection.

It is further recommended that the City conduct a more detailed evaluation of the program and investment requirements associated with such a conversion to single sort collection and processing by issuing a Request for Proposal (RFP) to determine the actual collection and processing costs. This evaluation would include equipment options and costs, processing and marketing arrangements, route requirements, and program investments and savings. RRS and SEH are prepared to oversee that process or to assist Minneapolis in defining an RFP to present to vendors to get the best proposals.

APPENDIX I: HENNEPIN COUNTY RESOLUTION

Hennepin County, Minnesota

RESOLUTION NO. 11-0306R2

[2011]

www.hennepin.us

The following Resolution was offered by Commissioner Opat and seconded by Commissioner McLaughlin:

WHEREAS, Hennepin County has been a leader nationally in the management of solid waste for many years, and the recent expiration of long-term contracts, completion of purchase of facilities, and developments in new technologies for recycling waste and organic materials have created new opportunities for improvement in the County's solid waste management system; and

WHEREAS, the Hennepin County Board unanimously adopted Resolution 09-0345R1 directing staff to review current waste abatement goals, recommend new increased 10-year targets for waste reduction, recycling and composting, and identify a variety of strategies to achieve them; and

WHEREAS, Hennepin County conducted an extensive public engagement and stakeholder process over the past year to discuss waste management issues with city recycling coordinators, environmental commissions, residents, waste industry representatives, and others to discuss and get feedback on potential strategies to increase the County's recycling and organics recovery rate; and

WHEREAS, the Minnesota Pollution Control Agency (MPCA) recently approved the Metropolitan Solid Waste Management Policy Plan which establishes new goals for Hennepin County in managing municipal solid waste which are 1% by source reduction, 45% by recycling, 3% by organics recovery, 32% by resource recovery, and a maximum of 20% by landfill by 2015; and by 2020, the goals are 2% by source reduction, 47% by recycling, 4% by organics recovery, 32% by resource recovery, and maximum of 17% by landfill; and

WHEREAS, Hennepin County will need to revise its Solid Waste Management Master Plan to show how it will reach the new state goals for source reduction, recycling, organic waste and resource recovery, and landfilling; and

WHEREAS, Hennepin County has been an active participant in the Solid Waste Management Coordinating Board (SWMCB), a joint powers board of six metro counties whose mission is to increase the efficiency and environmental effectiveness of the solid waste management system in the metropolitan area; Now, Therefore,

BE IT RESOLVED, that Hennepin County adopts the goals established by the Minnesota Pollution Control Agency (MPCA) in its Metropolitan Solid Waste Management Policy Plan except that the county will establish an organics recovery goal of 6% by 2015 and 2020; and

BE IT FURTHER RESOLVED, that the County will prepare a Solid Waste Management Master Plan to transform its solid waste system emphasizing waste management practices at the higher end of the waste management hierarchy to achieve the MPCA's goals; and

BE IT FURTHER RESOLVED, that the Residential Recycling Funding Policy be revised to:
- specify materials to be collected, require single or dual sort collection methods, and require use of County educational and promotional materials for municipal programs;

- establish municipal recycling goals to assure the County achieves its recycling goals by 2015;

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- continue current distribution of all SCORE funds received from the state to all cities within Hennepin County for their recycling programs, and require a municipality to negotiate an improvement program and demonstrate measurable results in order to retain its SCORE funds if the municipality is not on a path to achieving its goals by 2015;

- conduct periodic monitoring of municipal programs to assess progress in achieving the city's goal and to determine whether adjustments are necessary; and

BE IT FURTHER RESOLVED, that the County continue to provide Incentive Grants from the Solid Waste Enterprise Fund to help achieve the adopted waste management goals; that existing grants for assistance to cities and schools to recycle organic waste and a reduced tipping fee to waste haulers for organic waste disposal at the Brooklyn Park Transfer Station should be continued; and that the County should continue to collaborate with SWMCB to evaluate options to increase the number of companies in the region that can accept organic waste from institutions, businesses and residents for composting or anaerobic digestion; and

BE IT FURTHER RESOLVED, that the County cooperate with municipalities and building owners and property managers to ensure recycling at multi-family housing and focus the county's efforts in the cities of Bloomington, Brooklyn Park, Brooklyn Center, Crystal, Edina, Minneapolis, New Hope, Plymouth, Richfield, and St. Louis Park where most multi-family housing in the county is located; and

BE IT FURTHER RESOLVED, that the County investigate opportunities with Waste Wise and other business organizations to inform, support, and promote recycling by businesses and target commercial areas where large volumes of recyclables and organic waste are generated; and work with SWMCB to study financial incentives to encourage recycling and organic waste recovery; and

BE IT FURTHER RESOLVED, that the County encourage recycling at local events by providing event planners and hosts with customized technical assistance and resources; and

BE IT FURTHER RESOLVED, that the County deliver robust education campaigns that motivate behavior change by individuals; strengthen partnerships with municipalities, community groups, haulers and others to promote our programs and services; maintain the Community Power Grants provided to community organizations; and expand the use of volunteers through programs like the new Master Recycler Program; and

BE IT FURTHER RESOLVED, that staff review outcomes, results and accomplishments in procuring environmentally preferable products for the County per Board Resolution 01-4-263 and recommend changes and updates to the procedures as necessary to maximize County procurement of environmentally preferable products by March 31, 2012; and

BE IT FURTHER RESOLVED, that the County review past efforts to support and recycle building and other non-MSW materials and work in conjunction with the PCA and SWMCB to identify opportunities to increase recovery of building and other non-MSW materials identified in the PCA Policy Plan for reuse, recycling, and conversion to energy; and

BE IT FURTHER RESOLVED, that staff be directed to draft amendments to Ordinance 13 to include recycling and organics separation goals consistent with the goals established by the MPCA in its Metropolitan Solid Waste Management Policy Plan, and Amendments to Ordinances 2 and 17, which license waste facilities and waste haulers, to require reporting of recycling rates and volumes to provide the information necessary to measure progress in achieving the county's solid waste management goals; and

BE IT FURTHER RESOLVED, that staff be directed to negotiate a contract with Rational Energies for lease of space at the Brooklyn Park Transfer Station to recover plastic and metal from the incoming waste for recycling; require the company to hire social service organizations to provide staff to sort the waste; evaluate the potential of this process to separate organic waste for recycling into compost; and evaluate the option of replicating this initiative to recover plastic and metal at HERC; and

BE IT FURTHER RESOLVED, that the County supports Covanta Energy in its effort to seek a change in the conditional use permit with the City of Minneapolis and the MPCA's environmental review of the additional 11% throughput at HERC to achieve the resource recovery goal in the MPCA's Policy Plan; and

BE IT FURTHER RESOLVED, that Hennepin County in cooperation with Covanta Energy will actively seek customers for excess steam generated by HERC to optimize waste-to-energy performance.

BE IT FURTHER RESOLVED, that the Hennepin County Environmental Services and Property Services departments will review the most commonly used materials, utensils and disposable products used internally at Hennepin County to identify the most easily recyclable or compostable alternatives.

BE IT FURTHER RESOLVED, that staff be directed to report periodically to the Hennepin County Board on progress in achieving the source reduction, recycling, organics recovery, resource recovery, and landfilling goals established for Hennepin County in the MPCA's Metropolitan Solid Waste Management Policy Plan.

The question was on and there were 7 YEAS and 0 NAYS, as follows:

County of Hennepin Board of County Commissioners	YEAS	NAYS	ABSTAIN	ABSENT
Mike Opat	X			
Mark Stenglein	X			
Gail Dorfman	X			
Peter McLaughlin	X			
Randy Johnson	X			
Jan Callison	X			
Jeff Johnson	X			

RESOLUTION ADOPTED ON 7/21/2011

ATTEST: _____

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APPENDIX II: REVENUE PROJECTIONS

TOTAL TONS

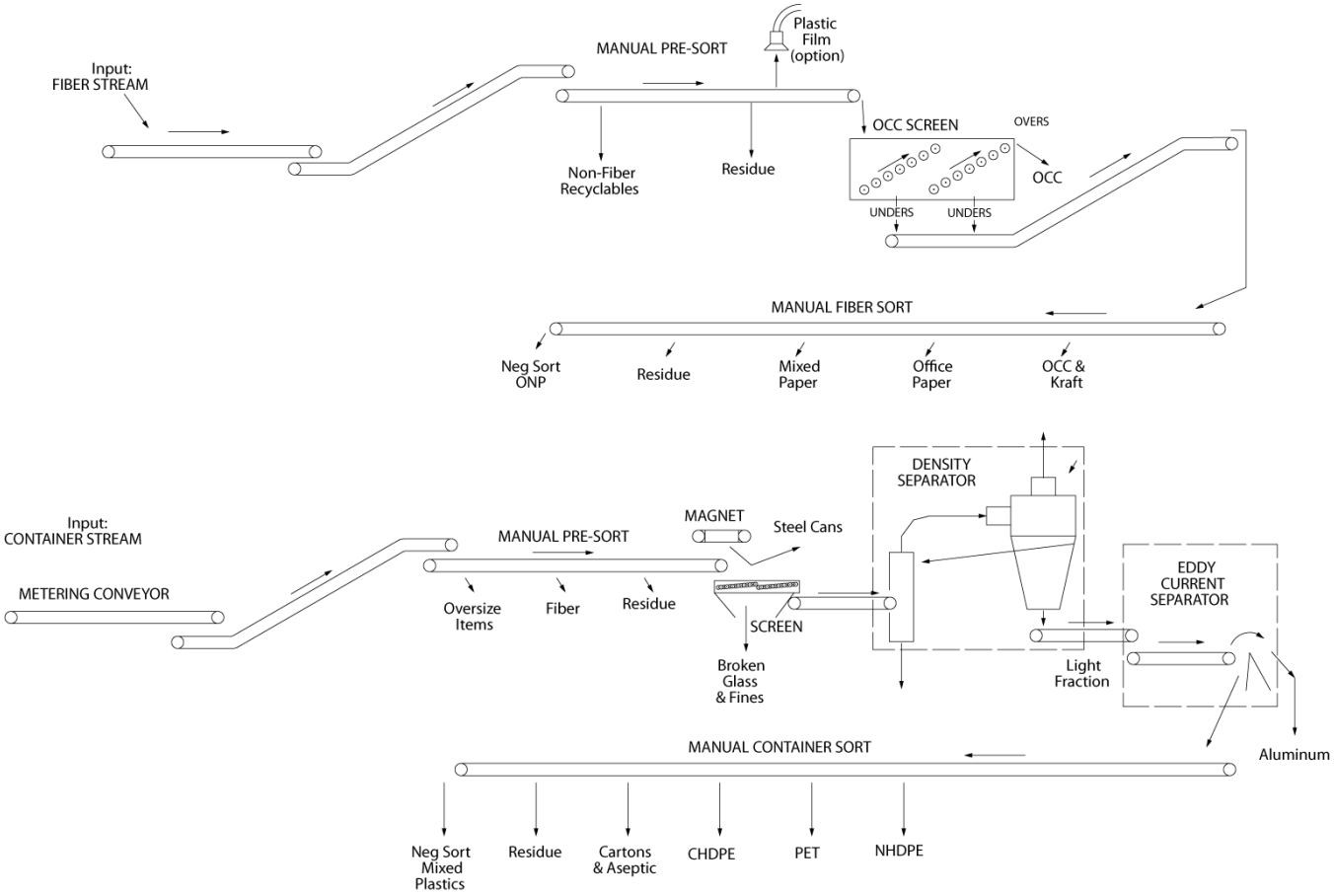
Material	Single Sort Semi Auto Biweekly	Single Sort Semi Auto Weekly	Dual Sort Semi Auto Biweekly	Dual Sort Semi Auto Weekly	Current Multi-sort Baseline
ONP	10,192	10,192	8,493	8,493	6,466
GLASS-CL	2,791	2,791	2,325	2,325	1,771
GLASS-BR	3,192	3,192	2,660	2,660	2,025
GLASS- GR	2,861	2,861	2,384	2,384	1,815
ALUM	368	368	307	307	234
STEEL	859	859	716	716	545
PLASTIC COMBINED	2,132	2,132	1,777	1,777	1,353
OMG	1,932	1,932	1,610	1,610	1,226
OCC	1,490	1,490	1,241	1,241	945
RMP- RES MIX	2,401	2,401	2,001	2,001	1,523
OTD	194	194	162	162	123
TOTAL	**28,411**	**28,411**	**23,676**	**23,676**	**18,026**

NET REVENUE

ONP	$(150,328)	$(150,328)	$(125,273)	$(125,273)	$(95,380)
GLASS-CL	$(76,739)	$(76,739)	$(63,949)	$(63,949)	$(48,689)
GLASS-BR	$(182,763)	$(182,763)	$(152,303)	$(152,303)	$(115,960)
GLASS- GR	$(236,746)	$(236,746)	$(197,288)	$(197,288)	$(150,210)
ALUM	$457,640	$457,640	$381,367	$381,367	$290,363
STEEL	$126,044	$126,044	$105,037	$105,037	$79,972
PLASTIC COMBINED	$756,808	$756,808	$630,673	$630,673	$480,179
OMG	$(28,490)	$(28,490)	$(23,742)	$(23,742)	$(18,076)
OCC	$3,352	$3,352	$2,793	$2,793	$2,127
RMP- RES MIX	$(66,024)	$(66,024)	$(55,020)	$(55,020)	$(41,891)
OTD	$(5,347)	$(5,347)	$(4,456)	$(4,456)	$(3,392)
TOTAL	**$597,407**	**$597,407**	**$497,839**	**$497,839**	**$379,042**

APPENDIX III: DUAL SORT PROCESS FLOW DIAGRAM

DUAL-STREAM PROCESS FLOW DIAGRAM



APPENDIX IV: SINGLE SORT PROCESS FLOW DIAGRAM

SINGLE-STREAM PROCESS FLOW DIAGRAM