Single Stream Recycling Best Practices Manual

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February 2007

Cover Photo: Plastics, glass and metal contaminants pouring out of a drum pulper at a newsprint mill.

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The statements and conclusions in this report are those of the Authors, and not necessarily those of any of the organizations that provided funding for this Manual.

Publication # DRRR-2011-029

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Acknowledgements

The authors would like to thank all the many people and organizations that have assisted us in preparing this Single Stream Recycling Best Practices Manual, and the companion Single Stream Recycling Best Practices Implementation Guide.

The following organizations, representing every sector of the recycling cycle, have provided funding for this project: The Alameda County Waste Management Authority, American Forest & Paper Association, American Plastics Council, California State Department of Conservation, Forest Products Association of Canada, Glass Packaging Institute, GreenWaste Recovery, and Sonoma County Waste Management Agency.

We would also like to thank the many processors, equipment manufacturers and recycled product manufacturers who graciously welcomed us on tours of their facilities so that we could better understand the impacts of collection on processing and manufacturing operations.

We would like to thank the many people who inspired us, arranged essential contacts, and gave us valuable feedback on our work, including Steve Apotheker, Dave Church, Lynn France, Delyn Kies, Gayle Lock, Eric Lombardi, Fran McPoland, Al Metauro, Chaz Miller, Cathy Norris, Ron Perkins, Jerry Powell, Annette Puskarich, Ralph Simon and Peter Slote.

There were over 170 Participants at the California Single Stream Recycling Roundtable that was held in Sacramento in May 2005. Each of the participants contributed to this Manual and the Implementation Guide. In particular, all the presenters' unflinchingly candid presentations helped all of us find paths towards best practices. We are grateful to EPA-Region 9, the Whole Systems Foundation, and the Martin-Fabert Foundation for their support for the Roundtable and publication of its results afterwards.

Many thanks to all of the reviewers who submitted comments on drafts of the Manual and Guide. There are too many to list, but we took all of the comments to heart in making the Manual and Implementation Guide the best possible.

And finally, we would like to thank our families, who put up with our working many, many long hours to research and write these documents.

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EXECUTIVE SUMMARY

Recycling is a dynamic system that is continually evolving to embrace new opportunities and address new challenges. Over the past five years, it has changed dramatically as collectors have introduced innovations and new collection efficiencies in the form of single stream recycling programs.

These innovations are very popular with an increasing number of communities, rapidly growing to at least 500 programs.

Local governments cite many recycling benefits derived from switching to single stream collection, including multiplying the volume of recovered materials, boosting the diversion rate from the local landfill, increasing recycling participation by residents and businesses, and reducing collection costs. Many communities also welcome the opportunity to add new categories of materials to their single stream programs, such as mixed paper. Some are even able to start additional separate collection programs, such as green waste, because single stream's collection efficiency frees up trucks and personnel.

Single stream programs cover a wide range of options, but most communities particularly appreciate that commingling the recovered materials allows for automated recycling collection. While some single stream programs continue to use manual collection of multi-bin systems, those that have switched to automated wheeled cart collection have gained significant cost savings through reducing worker injury rates and workers compensation costs.

However, the introduction of single stream collection systems has not had such uniformly positive results for recycled product manufacturers. Instead, it has accelerated an already pronounced slide towards poorly sorted recovered materials, with glass, plastics and metals being delivered to paper mills in bales of fiber, the wrong types of fiber going to paper mills that can only use specific grades, and increased contamination, as well as materials lost to plastics, glass and aluminum manufacturers.

Recyclable materials that were recovered for recycling in community programs but then sent to the wrong types of manufacturers generally end up in landfills near the mills. In other words, poor processing trashes recyclables.

Manufacturers have seen their costs increase significantly for cleaning and screening the poorly-processed materials, repairing damage to equipment, more frequently cleaning and replacing equipment, purchasing new raw materials to replace those that were unusable, and landfilling the recyclable materials they cannot use.

While more than 75% of recovered materials from many single stream curbside programs are paper fiber, the problems created by delivery of poorly sorted recovered materials affect all recycling manufacturers. Glass and paper fibers mixed in with the plastics, or ceramics and plastics mixed into the glass, or glass mixed with aluminum cans all present serious problems for those manufacturers. Not only do these unsuitable materials cause damage and increase costs for the mill they are sent to, they also represent significant losses to their own materials industries, which need them for their own recycling production.

Yet manufacturers who use recovered materials remain optimistic about the potential for single stream programs to increase the volume of materials available to them, once the quality issues are solved.

Processing: Still Catching Up To Collection Changes

Poor quality recyclable materials result from the challenge for processing facilities in separating highly commingled recyclables back into their original separate material types, appropriate for each of their markets. Single stream innovations were first introduced by collection companies, and collection is where the efficiencies and cost savings are concentrated. Recycling processing facilities are still experimenting with their design and functioning to determine how best to take apart the mix of materials that single stream collection puts together.

This dilemma has historical roots. The development of single stream programs coincided with changes in economic signals affecting recycling markets as more local governments in the U.S. and Canada provided curbside recycling collection programs to their residents. Earlier, when brokers collected and sold only high value recovered materials, manufacturers could control the volume and quality through price signals. They increased the prices they paid when they needed more volume or higher quality and lowered the price when they had too much volume.

But once curbside collection programs started, the volume of recovered materials was continuous, with no reference anymore to price signals. This changed recycling from demand-side markets to supply-side markets, where materials are collected to keep them out of landfills, not in response to market needs.

The resulting lower prices undermined processors' concern about the quality of materials delivered to manufacturers and increased the cost of curbside programs. So the collection industry looked for ways to retool and redesign to lower costs. Now the processing sector needs to adjust its design and equipment to meet the collection challenge.

Recycling Requires Collaboration

This Single Stream Best Practices Manual and its companion Single Stream Best Practices Implementation Guide include extensive discussions about processing. However, every part of the recycling system plays an essential role in ensuring that single stream fulfills its potential to benefit the whole system.

The recycling cycle represents a collaborative system, and no one sector can operate independently of the others. The success of recycled product manufacturers depends on the success of processors to properly sort the materials they receive. Processors, in turn, depend on collectors to pick up loads of recyclables from residents who understand what should go into their recycling carts and what should not.

Problems in any part of the system require resolution or ultimately every sector suffers, even those that originally benefited. Receiving poorly sorted materials from a processor discourages manufacturers from investing in new or expanded recycled product manufacturing capacity and even may cause some to close or return to using raw virgin resources. Low quality recovered materials can lead to defects in finished products, which threaten buyers' acceptance of recycled products. If customers, whether industrial or consumer, do not buy products with recycled content, losses cascade back through the system. Quality problems with some recycled products may taint buyers acceptance of other recycled products, as well.

Any of these outcomes will ultimately threaten markets for the materials recovered in community recycling programs. So all recyclers have a stake in making sure that single stream recycling works as well for manufacturers and processors as it does for collectors.

Additionally, recyclers must ensure that recovered materials are usable by a wide range of recycled product manufacturers, not just those that make the limited number of products that can use commingled materials or those that can afford the labor costs of re-processing the recovered materials. Poorly processed materials particularly undermine domestic recycled product manufacturing and many of the types of recycled products that produce the greatest conservation benefits.

In designing a single stream program around best practices, the following points are essential to integrate.

- **Recycling choices must be made in the context of the whole system**, not just one sector. While single stream lowers costs for collection, it increases costs for processors and manufacturers. The potential increased volume can still make the added costs worthwhile, but only if collectors ensure the optimal functioning of the other sectors, as well.

- **Recycling should be implemented as a resource management system**, not a waste management system. Too often, recycling has been considered an "add-on" to a long-standing garbage collection program and therefore has been expected to pay its own way. Garbage collection, however, does not include the same financial requirements, since it is supported by user fees or local taxes. Commonly, this has led to all new costs being assigned to the recycling program, but all the savings assumed to accrue to the garbage collection system, even when many of those savings were produced by the increased recycling.

  In a resource management system, recycling is recognized as the centerpiece for managing residents' discards. Garbage is secondary and only constitutes what has not been recycled.

- **Modern recycling collects feedstock materials for manufacturing systems, and therefore must effectively support manufacturers' needs to meet demanding production specifications.** When collection is focused primarily on garbage, there are few quality requirements for materials that are landfilled. But since over half the discards from residential and commercial sources are recyclable, collection focus must shift to quality requirements that support recycled product manufacturing.

  Savings made through improved efficiencies in collection, such as those in single stream programs, must be invested in high quality processing that can meet a wide range of manufacturers' requirements.

- **Collection is not recycling**. Most of the public, and even many community recycling program managers, consider materials to be "recycled" once they are collected. This reflects the close relationship recycling program managers have with the collectors who work with them every day.

  But in reality, materials are not actually "recycled" until they are made into new products. So local recycling programs should be designed to maximize their materials' use in manufacturing.

- **"Diversion" is not recycling.** Diversion from landfills has become a major driver for many recycling programs, with some states and municipalities even operating under legislative requirements for achieving specific diversion goals. However, when poorly sorted materials are counted as "diverted" from local landfills but end up landfilled by manufacturers because they were not usable, they simply made a longer trip to the landfill and are not really diverted.

This is not a responsible outcome for "diversion." Rather, community recycling programs should incorporate data about the fate of their materials into calculating their diversion rate. They should know how much of their materials were actually usable, and also how much of the use resulted in continuously recyclable products.

Manufacturers can provide reports on "millage loss" to processors and community recycling program managers in order to more accurately determine a true diversion rate.

- **Local governments must set the goals and standards that will achieve a sustainable, healthy recycling system.** It is important for each recycling business to be economically successful because that ensures the recycling system's health and longevity. But that, in itself, is only the means, not the goal, of recycling.

  Rather, community recycling programs were developed to enhance public interest goals for conserving natural resources, water and energy, and strengthening environmental quality – values that sheer economic forces are not comprehensive enough to take into account. Municipal governments hold the broad expanse of both the public's and recycling's universal interests. That is why they must be the ones to drive the system to its highest potential.

  In order to ensure an optimally functioning whole recycling system, local governments must provide for recycling services that sustain all parts of the cycle, not just collection. Therefore, in the same way that local governments specify collection service requirements, they should also specify processing and marketing requirements, with input and feedback from the industries that will use the recovered resources in the manufacture of new products.

  Communities that accept processing that produces poorly sorted materials, even if there are markets for them, undermine the health of the recycling system. Recycled product manufacturers need to meet increasingly stringent specifications to satisfy the quality demands of their customers. Processors and collectors should make sure they produce the quality of materials manufacturers need to do it.

- **Well-sorted recovered materials expand recycling markets.** High quality sorted materials can be sold to a wide diversity of markets and support the whole range of products that can be made with recovered materials. Many sorted materials can be directed into products that can be recycled multiple times, producing conservation benefits and savings many times over. This is true "diversion" - ensuring that the materials take many steps away from the landfill by being able to be repeatedly recycled.

  Commingled materials have limited markets because most recycled products can use only certain categories of materials for production. For example, while commingled plastics can be used for many types of plastic lumber, other recycled content plastics products such as fiberfill, carpets, and plastic bags require a single type of plastic resin and cannot use others. Mixed fibers can be used to make paperboard boxes, the inner portion of corrugated boxes, shingles, and stiffening board products such as notepad backings and binder construction, but many other paper products require specific fiber streams only.

  Mixed fibers, for example, cannot be used to make newsprint, tissue products, printing and office papers, corrugated linerboard (the outside layers of corrugated boxes), or the printing surfaces for paperboard boxes (such as cereal boxes). But, other than tissue, these products are some of the most recyclable - not only can they be made with high percentages of recycled

content, but they can also be recycled many times, further extending and multiplying the conservation and environmental benefits.
Producing high quality recovered materials allows and encourages the expansion of products and manufacturers that can use recycled content, promoting healthier and more reliable markets for community recycling programs.

Similarly, the goal of recycling programs should be to maximize the recyclability of all its materials. While glass, for example, makes up a comparatively small percentage of recovered materials, it should not be wasted on a one-way trip as landfill daily cover or roadbase, when it could have been recycled infinitely as new glass bottles.

- **Build consultation and feedback loops from recycled product manufacturers into recycling programs**, including not only the manufacturers that currently buy the materials, but also those that would like to buy them if they were properly prepared. Recycling program managers should consult with manufacturers when they are designing or changing their programs, when they design and build a MRF, and as they regularly evaluate the operation of the processing facility and their entire program.

A Vibrant Recycling System Is Essential

Demand for consumer products is rapidly growing throughout the world and developing countries are building manufacturing plants at rates that are outstripping the sustainable use of raw materials. Recycling is increasingly critical as the foundation for sustainable production. Single stream collection programs promise to provide the increased quantities of recovered materials needed for this increased production. But the increased volumes are only favorable if they are usable by the production industries.

Recycling has to play a leading role in creating more environmentally sustainable manufacturing methods. It can only do that if recyclers step back, look at how best to encourage a vibrant, complete recycling system, and make sure that the changes made now will serve the promise of recycling both now and also in the future.

Leading organizations representing every part of the recycling cycle contributed to the development of this Single Stream Best Practices Manual and Implementation Guide, including the California Department of Conservation, the American Forest & Paper Association, the American Plastics Council, the Glass Packaging Institute, the Alameda County Source Reduction and Recycling Board, GreenWaste Recovery, the Forest Products Association of Canada, and the Sonoma County Waste Management Agency. They, and many more, also generously offered their time and expertise to give us tours, talk through ideas, and review drafts of the Manual. EPA-Region 9, the Whole Systems Foundation, and the Martin-Fabert Foundation supported development of the California Single Stream Roundtable in 2005 and publication of its results afterwards.

All of these organizations participated because, while they have many different stakes in the recycling system, ultimately they all appreciate the potential for new dynamism in recycling if increased quantities of recovered materials can be combined with the quality that manufacturers need. This Best Practices Manual is dedicated to helping community recycling programs fulfill that promise.

CHAPTER 1: INTRODUCTION

PURPOSE OF THIS MANUAL

The purpose for this Manual is to:

- Evaluate single stream recycling programs in the context of the whole recycling system,
- Identify where single stream tends to create or exacerbate problems,
- Identify solutions and best practices, and
- Identify points of leverage for implementing solutions.

OVERVIEW

This Single Stream Recycling Best Practices Manual, along with the companion Best Practices Implementation Guide, is dedicated to identifying features that optimize single stream recycling program practices. The goal of this Manual is to help communities get the best possible services that produce the highest quality materials for use in manufacturing new products.

It is local governments that control the system and provide the broad vision, but they must recognize that they have the ability to direct their programs through requiring implementation of best practices, whether they run their community recycling program themselves or contract the program out.

INTRODUCTION

Recycling System Changes

Recycling is a dynamic system that is continuously evolving to embrace new opportunities and address new challenges. As recycling developed and changed over the past 30 years, each sector – collectors, processors, manufacturers, and purchasers of recycled products – has had to adapt and adjust to keep the system running smoothly. After all, recycling is a collaborative system and no recycling company or sector operates in isolation. For example:

- If recyclable materials are not collected, manufacturers do not have the feedstocks they need to make new recycled content products.
- If collected materials are contaminated or poorly processed, manufacturers cannot make high quality products from them.
- If manufacturers do not buy recovered materials, collectors and processors have no markets and recyclables must be landfilled.
- If consumers do not buy recycled products, manufacturers have no incentive to continue making them and then, again, collectors and processors have no markets.

- If consumers contaminate recyclables, then they will not be able to be made back into new products.

To be successful, recycling must operate as a whole, interdependent system.

Single Stream Collection and Processing

Collection companies have led the most recent dramatic change in recycling. In order to reduce collection costs, increase their operating efficiency and produce other benefits, many communities are converting to collection programs that require no (or limited) sorting of materials by their residents.

Single stream collection programs are those that instruct residents to put all recyclables into the same cart or bin for collectors to load into a single compartment on their truck and haul these materials to a processor. This processor is then expected to sort all the recyclables back into clean, high quality feedstock streams appropriate to each type of manufacturer so that the materials can be used to manufacture new products.

Benefits and Challenges

One of the biggest attractions of single stream programs is the collection cost savings produced by the ease of automation. Not all single stream programs are automated. They range from manually collected bin systems to semi-automated carts to fully automated collection. In general, the cost savings are greatest with full automation and wheeled carts that make it easier for the residents to divert more materials and get them out to the curb for collection.

Most local governments that have switched to single stream are very enthusiastic about it. In addition to reduced collection costs, they cite additional advantages such as:

- Increased participation by residents,
- Increased amount of recyclables collected,
- Higher rates of diversion from landfills,
- Reduced worker injury and workers compensation costs,
- Potential for collection of additional types of materials.

But, while single stream programs may increase convenience for the residents and the collection companies, they can also increase the costs for processors and manufacturers.

If the collected materials are not properly processed, the manufacturing sector encounters production obstacles created by:

- Poor quality production feedstocks,
- Reduced operating efficiencies,
- Dramatically increased internal costs,

- Lost access to recyclables needed for manufacturing,
- Increased raw material costs to replace those too contaminated to use, and
- Increased costs from landfilling unusable materials.

The continuation of such production obstacles discourages manufacturers from expanding existing recycling capacity or the recycled content in existing products, as well as from investing in new recycling capacity, and may even lead to the loss of recycling mills.

While single stream recycling is most often financially positive for the collection sector, it requires increased investment in the processing sector and also increases costs across many different factors in the manufacturing sector. The market value of the recovered materials is also often lower than for multi-stream recycling programs because of recyclables that were degraded in collection and processing, which then encourages MRFs to make up profits by reducing processing.

Comparison to Other Systems

Single stream programs are by no means the only way to achieve increased efficiencies, nor are they the only source of the challenges. Dual stream programs can be automated and produce many of the same advantages as single stream programs. Materials from dual stream programs can also be poorly processed and create problems for manufacturers.

Single stream programs are not the best option in every area. Some smaller communities have found they cannot effectively pay for the added cost of processing equipment. Others find different approaches, such as dual- or multi-stream or wet-dry systems, to be more appropriate for their markets and community.

Most of the recommendations in this Single Stream Recycling Best Practices Manual are equally applicable to dual stream and multi-stream programs. Likewise, while many of the comments and examples assume that the recycling program is handled by contractors, they are equally applicable to programs operated by the municipal government itself.

While this Manual primarily describes residential curbside recycling programs, some single stream programs are venturing into adding materials from commercial establishments and multi-family complexes. The recommendations are applicable to these venues, as well.

BEST PRACTICES MANUAL: FOCUS

The focus of this Manual is on single stream systems because the number of these programs is growing rapidly and this has impacted the quality of materials recovered for reuse in manufacturing.

The goal of this Manual is to show that well designed programs can achieve high quality feedstock materials for manufacturers, instead of creating problems for them. Shortcomings in single stream programs often include:

- Program designs driven by requirements for diversion from landfills, without recognition that diversion, by itself, is not recycling.

- Single stream processing facilities that cannot separate out the mix of materials collected.
- Failure to include quality requirements for recovered materials in collection and processing contracts.

CHAPTER 2: CHALLENGES

Many people hold great expectations for single stream programs. Collection costs are usually lower, recycling rates typically increase, and fewer tons are sent to local landfills. Manufacturers generally support the expansion of single stream programs because they want increased volumes of recovered materials for their production systems.

These expectations can only be achieved over the long term, however, if the problems created by current programs are solved.

DEFINING THE DILEMMA

What Are The Problems?

Manufacturers report a series of problems created by poor quality materials being shipped to their mills. The quality of recyclables may be compromised if:

- Residents place so many inappropriate and contaminated materials in their recycling carts or bins that it is difficult to sort them out at the MRF.
- Collectors do a poor job of keeping recyclables separate from garbage, whether because of truck or route design, or worker training and incentives.
- Processors attempt to process volumes far beyond their facility's capability, accept streams of recyclables their MRF was not designed to process, do not have sorting lines that are designed to handle the materials they receive, or employ too few workers to produce high quality materials.
- Recyclables are sent to the wrong type of manufacturer. Even though they would have been perfectly acceptable at the right facility, they are considered contaminants at the wrong ones and usually end up being landfilled.

What Are Effects of These Problems?

Recycled product manufacturers are critical to the ongoing success of community recycling programs. If the quality of the recovered materials is not high enough, manufacturers are not able to make new products from them and the market for recyclables collected by communities is undermined. But very few municipal recycling programs seem to have been designed with manufacturing in mind. Rather, they focus on collection and sometimes processing because these are the most visible and immediate aspects of the local recycling system.

Since communities do not track their materials through the whole system, they may not even realize when the result is incomplete or improper processing and marketing. Recyclables change ownership many times as they work their way from collector to processor to manufacturer, and communities have not established contractual requirements to follow the materials.

Communities rarely seek input from recycled product manufacturers in the design of their recycling programs. As a result, many local governments are contracting for collection and processing services that no longer provide the quality feedstock materials that manufacturers

need. It is essential to recognize that "diversion" is not recycling and that materials are not "recycled" until they are made into new products.

Therefore, to achieve best practices, communities must incorporate the needs of manufacturers into their recycling programs if they want long-term success.

SYSTEM ECONOMICS

What is driving single stream collection? Several issues combine to make the biggest impact.

Mandated Diversion Rates - The concept of diversion is currently a critical driver because its introduction narrowed the goals of community recycling systems to diversion of wastes from landfills. Collection and processing practices are not nearly so critical in achieving diversion as they are when the program goal is to provide high quality recovered materials to manufacturers so they can meet stringent finished product specifications.

Collection Efficiencies - Automated collection systems reduce collection costs and lower worker injury rates. The higher capital costs can be more than offset by system efficiencies and reduced operations costs.

Challenging Government Finances - Recycling programs must be cost effective. Local governments are often strapped for funding and looking for ways to cut their costs anywhere possible. Reducing collection costs helps their bottom line when the perceived goal is simply to keep recyclables out of landfills.

Supply-Side Economics

Processors continue to follow market-driven pricing signals, even while the North American paper and plastics recycling markets have shifted to supply-side economics. Prior to 1990 and new legislation at state and local levels to encourage recycling programs, paper mills raised the prices they paid for recovered paper when they wanted more and lowered the price when they were getting too much. They also paid more for higher quality feedstock than for poorer quality paper.

But when communities began recycling collection programs without regard for the traditional market signals – even sometimes paying to have a manufacturer take their materials – the economic model changed. Now the price paid for their materials became irrelevant to many programs and therefore the quality became irrelevant to them, as well.

In fact, many processors now say that higher prices are often insufficient incentive for them to clean up materials because the cost to them to do so reduces their profit even more than the lower prices they receive for their mixed materials.

Mills need a specific minimum amount of recyclable materials for their production every day. With this fixed through-put requirement, combined with pricing signals that often no longer bring in the quality they need, mills often end up having to buy more volume than they should need because a greater percentage of the materials they buy is not usable. For example, for every ton of plastic bottles mixed into the recovered paper bales that come in, a paper mill has to buy another ton of fiber.

Point of Profit

While obviously important, cost of service and profit margins are not the primary goals for recycling. It is important for each recycling business to be economically successful because that ensures the recycling system's health and longevity. But that, in itself, is only the means, not the goal, of recycling.

At the same time, it is not reasonable to expect that a private company will reduce its profits to provide higher quality materials to a manufacturer than it is compensated for or required to provide. However, municipal recycling programs have been established to achieve resource conservation and environmental quality goals for the greater community's good, and the economics of the larger system must serve those goals.

Rather than operating as totally independent and unconnected cost centers, recycling participants need a unifying guide setting clear and achievable goals for the system as a whole. It is the responsibility of community recycling managers and coordinators to set the goals.

"Cost Effective" Services

Recycling programs must be economically sustainable. But this does not mean that responsible communities can only seek the lowest possible cost for recycling. Rather, they need to find the most cost-effective way to achieve their goals. Therefore, the goals should be set first. Then the cost for achieving the goals should be determined.

For example, communities do not buy the cheapest possible cars for their police force. They spend what is required to provide an effective vehicle for their officers. Likewise, when companies submit bids for recycling collection services, communities should not expect them to buy the cheapest possible trucks or the least expensive processing equipment available, but rather to make the appropriate capital investments. Just as collectors must buy trucks that will not break down on the route, even when they are not the least expensive, processors must buy the right types and sizes of equipment to properly process the recovered materials and meet the community's goals.

With this in mind, it is essential for local governments to identify the services that they wish to have provided, and then seek competitive bids for these services. Communities should pay the processor to produce quality materials that meet the manufacturing industries' specifications and not allow their processors to market recyclables of barely acceptable quality.

Who Pays?

It is essential to recognize the inequity that garbage collection is paid for by service fees, while recycling is often expected to pay its own way. Even when increased recycling clearly reduces the amount of garbage collected, the added costs tend to be attributed to the recycling system while the savings and benefits are assigned to the waste management system.

Recycling programs are often viewed as an add-on to the existing garbage collection system, not as an essential part of an integrated system. At this point, the recycling costs are clear, but the savings to the other parts of the system – garbage collection and disposal – are not clear. Further, while some of the savings from recycling are direct and show up immediately, some may be incremental and not realized for some time. So the cost for disposal of the collected

garbage may decline immediately when additional materials are diverted by recycling, but savings from garbage collectors picking up fewer cans of garbage will not be realized until the garbage collection system is rerouted. In some cases, garbage collection frequency may even be reduced if more of the household materials are being collected instead in the recycling stream.

When recycling programs are introduced or expanded, they become part of the overall resource management system that should replace the former focus on waste. As such, the cost of recyclables collection should become part of the cost of the total system that is to be paid for by the ratepayers. Clearly, if a community decided to collect garbage twice a week instead of once a week, the cost of this service would be considered to be part of the waste management system and would not have to stand alone. Likewise, if the community has elected to collect recyclables, then the community should reorient its collections to focus on a resource management system, with recycling a part of the overall management system, not a stand-alone cost center.

Finally, some communities realize that the revenues from the sale of recyclables can offset only part of the cost of service. But they do not compare that partial income to the alternative cost of having to pay to dispose of all of the garbage they collect.

CHAPTER 3: GOALS AND SOLUTIONS

Best practices in single stream recycling require communities to focus squarely on the goal of returning resources to manufacturing in order to reduce the need for extraction of raw materials. Reducing the need for natural resources also has the potential to conserve water and energy and reduce pollution.

The range of recycled products that can be made from recovered materials is wide, with some recyclable multiple times (e.g. glass bottles, newsprint, printing and writing paper, corrugated boxes) and others intended for disposal after use (e.g. tissue products). When recycling programs ensure that enough high quality recovered materials are available to make products that can be repeatedly recycled, the conservation and environmental benefits are multiplied, the volume of recovered materials available is extended to its maximum, and recovered materials are then available to support all levels of recycled product manufacturing.

RESOURCE MANAGEMENT

Recycling programs should not be implemented to manage “wastes,” nor are they a form of disposal. Rather, recyclables are resources that should be used to their maximum, and their collection turns community recycling programs into a ***Resource Management System***. Maintaining a resource-based focus makes much clearer all the myriad choices that add up to best practices.

Recognizing recycling as a resource management system makes clear that "diversion" and "selling the processed material," while important activities, are not the ultimate goals for a successful recycling system. Neither ensures that materials will be manufactured into high quality products, closing the loop whenever possible.

There are few quality requirements if a material is collected as a waste or if it is destined for a landfill. But a manufacturer has tight production tolerances and must meet increasingly stringent specifications to satisfy the high quality demands of its customers — who are central to continuing the recycling system. Materials that are recovered, as opposed to disposed of, must be treated as manufacturing feedstocks.

Communities should insist that their collectors and processors handle recyclables as resources and commodities to be processed for reuse, not as materials to be diverted from landfill. To maximize and reinforce the concept of returning recovered materials to high value manufacturing, contracts for recycling services should require that the collected materials not be used for landfill alternative daily cover (ADC) or other non-feedstock purposes.

RESPONSIBILITIES

Each sector of the recycling cycle has specific responsibilities that, taken together, make the system successful. Failing to accomplish any of these responsibilities frays and undermines the system.

- **Governments** at all levels have a responsibility for protecting the community’s collective interest in conserving natural resources and energy, ensuring clean air and water, and promoting healthy, satisfactory living standards for their citizens. Because municipal governments in the U.S. and Canada are responsible for organizing collection and

processing of recyclables, they are the key to ensuring that our recycling system operates to its highest potential. They set the goals and standards that will be used to achieve a continuous, healthy system, and they design systems to maximize public participation.

- **Collectors** recover recyclable materials efficiently while making it as easy as possible for the greatest number of citizens to participate yet, at the same time, maintaining sufficient materials quality.

- **Processors** separate collected materials into appropriate streams to meet the needs of the manufacturers who ultimately use them, while maintaining economic efficiency in their own operations.

- **Manufacturers** use the recovered materials to make new products that meet the high quality specifications their end-customers demand.

- **Consumers** purchase the recycled products because they know their purchasing dollars are doing double duty: not only are they procuring useful products, they are also supporting resource conservation and a healthier environment. Afterwards, they set the appropriate recyclables out for the collectors to send back through the system.

WHO IS IN CHARGE?

Recycling is a system that is dependent for success on every part of the system being fully involved. All the different companies and participants in each sector of the system work hard to make their part of the system successful. But someone also has to drive the train, and manage the system as a whole.

Municipal governments are the only participants in community recycling systems that hold enough of recycling's overall interests to consistently drive the system to its highest potential. They hire the collectors, direct the processors, and can assist the manufacturers in obtaining high quality feedstock materials as inputs for their new products. Additionally, local governments decide what materials their residents can recycle. They must recognize that they have both the responsibility and the authority to set the terms for how the system will function.

Therefore, local governments must contract for recycling services that serve all parts of the cycle, not just collection. In the same way that recycling contracts specify collection service requirements, they should also specify processing and marketing requirements, with input from the industries that will use the recovered resources in the manufacture of new products.

To achieve the best practices goals, it is essential that those who design and oversee recycling programs direct them to:

- Produce quality materials that meet manufacturers' specifications (which are driven by their customers' requirements and specifications),

- Meet specifications for a wide variety of manufacturers, not just those with the least demanding conditions, and

- Produce quality that allows the materials to be recycled repeatedly, thereby stretching quantities and exponentially increasing the amount of natural resources conserved.

CHAPTER 4: PROGRAM SYSTEM DESIGN

There's a lot more to recycling than just collecting recyclables.

The recycling program design must relate the community's goals to the entire system. The design must work now as well as long into the future. The program design must include the collectors, processors, and the product manufacturers. It must also provide for public education.

From the very beginning of the process, the community must clearly delineate its goals and write them in its contracts with its collector and processor.

In addition to the goals of the program, the community should identify its specific objectives, including the quality of the product to be shipped to market.

The community should require that recyclables be processed to the specifications requested by the buyers of the materials.

Best practices dictate that, to the extent feasible, the collected recyclables be directed to manufacturers who will make products that close the recycling loop, can be repeatedly recycled, or otherwise constitute high value products. This is what the residents expect to happen to their recyclables. Using recyclables for low value uses such as alternative daily cover, roadbeds, or burning for energy should be the last resort and avoided whenever possible.

In designing its program, the community should decide:

- What materials should be collected?
- How will residents be educated about how to participate in their recycling program and who will be responsible for this education?
- How will the public be encouraged to deliver the cleanest materials to the collector?
- How will the collector be encouraged to deliver the cleanest materials to the processor?
- What expectations will there be about processed materials' quality and appropriate markets?
- Will the program build incentives and/or penalties into contracts with the collectors, processors and any subcontractors?
- What types and frequencies of reporting will be required, by whom and to whom?

WHAT MATERIALS SHOULD BE COLLECTED?

The list of materials to be recovered depends on several factors, including the community's recycling goals, the processing facility's capabilities, and available markets. The higher the diversion rate the community is attempting to achieve, the more material types it will need to collect. But increasing the number and diversity of material types will increase collection and processing costs, as well as the likelihood that much of the additional materials will become residue unless the processing system is carefully designed to handle them.

Residents should be asked to separate for recycling only those materials that can successfully be marketed.

Keep in mind that all the materials that are collected mixed together in a single stream system must be sorted back out at the processing center. The more complex the load, the more extensive, and expensive, the processing required.

If the materials are to be processed at a MRF that has not yet been constructed, then there is an opportunity to design the facility to specifically handle the full range of materials the community wants to recycle. If the materials are to be processed at an existing facility, then either the materials to be collected should be matched with the capabilities of this facility or the community and processor should develop a plan to upgrade the facility to handle the additional material types.

Communities should also consider matching their program to those of surrounding communities, especially if the program will share a processing facility with other recycling programs.

This will also make the public education and promotion program easier to communicate to residents.

PUBLIC EDUCATION AND CLEAN RECYCLABLES

Most residents want to recycle more materials than are collected by their recycling program. In many cases, when they are in doubt about whether or not a material is collected – such as garden hoses, pizza boxes, light bulbs, and plastic toys – the residents put them into the recycling cart, expecting the processor to recycle them.

To maintain recovered material quality it is essential to:

- ***Keep the list of acceptable materials simple and easy to understand,***
- ***List materials that are not acceptable,***
- ***Provide clear and easy-to-understand informational materials at every opportunity, and***
- ***Give immediate feedback to residents who set out non-recyclable (or non-targeted but recyclable) materials.***

The more extensive the list of collected materials, the more extensive the on-going promotional program must be. So if your community is not prepared to support a major promotions program, the list of collected materials should be simple rather than complex. (See Chapter 5: *Promotion and Public Education* for more detailed information.)

COLLECTING CLEAN MATERIALS

It is not uncommon for materials arriving at a processing facility to already be contaminated in one of three ways:

1) Non-recyclable materials (trash or garbage) are placed in with the recyclables by the resident,

2) Potentially recyclable materials that are not part of the community's collection program are placed in with the recyclables, and

3) Fully recyclable materials are rendered non-recyclable by being mixed with other materials in such a way that they cannot be adequately cleaned or separated by the processor for reuse by recycled product manufacturers.

The first two categories are primarily contamination caused by residents incorrectly sorting their recyclables from trash. But the third category should be prevented by the collector's methods of recovering recyclable materials and the processor's handling techniques.

The community should be very specific about materials handling requirements, and the collection company should spell out how it will ensure these requirements are to be met.

The community should require a sampling program to monitor the quality of collected loads when they reach the processor, in order to identify and address problems as early as possible.

The community may also choose to provide the collection company financial incentives for clean loads and penalties for loads that are contaminated.

If the program intends to collect any of the following materials, special consideration should be given to their handling:

- Flat plastic bags are hard to remove from paper and are easily contaminated by the left-over liquids in beverage containers. If plastic bags are to be collected in a program, residents should be required to place the bags within other bags and only set out full bags, not loose individual ones.

- Poly-coated and waxed cartons, wet strength packaging (beer and soda boxes) and food-contaminated paper cannot be recycled by most paper mills, but are compostable. Therefore, they should not be included in single stream programs, unless they will be sorted from the mix and shipped as a separate commodity to a mill that is designed to handle them or to a compost facility.

PROCESSING FOR CLEAN MATERIALS

The contract between the community and the materials processor should be very specific about processing requirements and specify the quality of the materials to be marketed.

The community may choose to provide financial incentives for the processor to ship clean materials and financial penalties for loads that are contaminated.

To verify the quality of the materials, the contract should require manufacturers to provide reports to the community and the processor on the quality of the loads received.

A processor may declare that they achieve quality that is "good enough" for the mills that buy materials from them. But in recycling, "good enough" is not really good enough.

The materials sold by the processors are feedstocks for manufacturing processes and they should meet high quality standards.

The specific high quality standards vary by the type of material, manufacturing mill and product that the recovered material will be used to make. The community should require processors to meet the mills' quality requirements, not simply produce mixed materials that a buyer will take.

Mills regularly provide feedback to the processors from whom they purchase raw materials for use in manufacturing. Local governments should include a condition in the processing contract that the processor require the mills that buy its materials to provide feedback to both the processor and the community on the quality of materials shipped.

The community should request that the manufacturers sample the materials received to verify the quality of the recyclables.

MARKETS

Since the local government is responsible for the recycling program design and operation, communities should be specific about the marketing arrangements for the materials collected. The local government should insist that the cost of achieving this standard be included in the cost of the program. For example:

- A community can specify that some percentage of the glass received should be processed to a specification that would be "furnace ready" for a beverage container manufacturer. This makes clear that a low bid proposing to use the recovered glass for aggregate would be unacceptable.

- It may be in the community's best interests to support local recycled product manufacturers. The contract could specify that materials must be processed to specifications acceptable to these local mills. If necessary, the community can even offer to pay the contractor any difference between the open market value of the material and what the local manufacturer is able to pay, in order to keep the local jobs and sales tax revenues.

REPORTING

Communities should specify what data they want their contractors to report to them.

This should include information on any or all aspects of the program. Commonly, communities require reports that describe the collection program operation but not the processing operations. Best practices require that reports submitted by the collector and processor include information on collection as well as the recovery rate for each commodity type delivered to the processing facility, the process residue amount and composition, and the marketing of the recyclables.

Processing contracts should specify that the contractor report on the market and end use of each commodity and grade recovered.

This information should be shared with the community. It is important for your residents to know what is happening to the materials they separate for recycling.

The reports should describe any significant changes in the operations of the collector or processor that have been made since the prior reporting period.

Monthly reports are recommended so that there is no lag in the community finding out about successful program changes and potential problems.

Communities should not ask a contractor to report information that they are not prepared to review and the reports should not be required to be more frequent than appropriate for the data concerned.

INCREASED MATERIAL RECOVERY

Communities that have switched from source-separated programs to single stream often report a significant increase in recovered materials. Frequently they initially report a doubling of collected materials, although over time the percentage usually settles back to a 20-30 percent increase from the non-automated multi-stream collection program.

Some of the factors that increase recovery rates include:

- Providing additional storage capacity (more bins or large carts),
- Switching from a multiple small bin system to wheeled carts, which makes it easier for the residents to store and bring recyclables to the curb,
- Promoting the recycling program,
- Adding more material types, whether to the single stream collection system or to a separate collection made feasible by consolidating recycling into one cart (e.g. starting a separate greenwaste collection). The addition of new materials categories increases volume of all collected materials.

The relative size of the garbage and recycling containers is a strong signal to the resident. When residents receive small recycling bins and large garbage cans, the subliminal message is, “Recycle a little, and throw the rest away.” With large recycling carts and small garbage carts, the message is, “Recycle as much as you can and throw away only the left-overs.”

Note, however, that many communities are learning that reducing the garbage cart size too much or charging for garbage by volume (pay-as-you-throw, or PAYT) can encourage residents to dump over-volume garbage into the recycling cart. Communities that provide the same size carts for both garbage and recycling tend to have a lower contamination rate than communities that push residents to use a small garbage cart.

Many communities have recognized that any promotional attention to their collection program tends to increase participation, at least temporarily. (This is true for dual stream collection programs also.) So program promotion is a key to both increasing recovery rates and keeping the materials free of contamination.

SUMMARY: PROGRAM DESIGN BEST PRACTICES

From the very beginning of the process, the community must clearly delineate its goals and write them into its contracts with collectors and processors.

In addition to the goals of the program, the community should identify its specific objectives, including the quality of the product to be shipped to market.

Materials collected mixed together in a single stream system must be sorted back out at the processing center. The more complex the load, the more extensive, and expensive, the processing.

Communities should consider matching their program to those of surrounding communities, especially if the program will share a processing facility with other recycling programs.

Residents should be asked to separate for recycling only those materials that can successfully be marketed.

It is essential that program education is frequent, easily accessible to the public and easy to understand, to ensure that the recovered materials stream is as clean as possible.

Maintaining recovered materials quality is easier if the program:

- *keeps the list of acceptable materials simple and easy to understand,*
- *lists materials that are not acceptable,*
- *provides clear and easy-to-understand informational materials at every opportunity, and*
- *gives immediate feedback to residents who set out non-recyclable (or non-targeted but recyclable) materials.*

The community should be very specific about materials handling requirements and the collection company should spell out how it will ensure these requirements are to be met.

The community should require the processors to process the recyclables to the specifications required by the manufacturers who use the materials.

The community should require a sampling program to monitor the quality of collected loads when they reach the processor, in order to identify and address problems as early as possible.

The community may also choose to provide the collection company financial incentives for clean loads and penalties for loads that are contaminated.

The community may choose to provide financial incentives for the processor to ship clean materials and financial penalties for loads that are contaminated.

To verify the quality of the materials, the contract may require buyers or manufacturers to provide the community and processor reports on the quality of the loads received.

Materials sold by the processors are feedstocks for a manufacturing process and they should meet high quality standards.

Sampling of materials about to be shipped to manufacturers may also be used to verify the quality of the recyclables.

Communities should specify what data they want their contractors to report to them.

Processing contracts should specify that the contractor report on the market and end use of each commodity and grade recovered.

CHAPTER 5: PROMOTIONS AND EDUCATIONAL MATERIALS

Communication at every level is essential to a successful single stream recycling program, both when first introducing and rolling out the program, and throughout the life of the program. A public that understands how best to participate in their recycling program supports the success of both the collection and processing systems.

Single stream collection systems do not reduce the need for public education. Clear messages about what residents should save for your specific program, how they should prepare the materials, and whether or not they are doing it right are essential.

The four primary messages you need to communicate to your community are:

- what to recycle
- what not to recycle
- how to prepare the recyclables
- what happens to the recovered materials

WHO IS RESPONSIBLE FOR PROMOTION AND EDUCATION?

The responsibility for promotion and public recycling education will vary by community. A number of factors, including the strengths of each participant, must be adapted to the realities of the specific community program. ***Local governments are in the best position to match the promotional materials to their program goals***, so they should lead the effort, and enlist the assistance of the collector in delivering the message to the residents.

Municipal governments may have their own in-house capacity for creating promotional materials or they may contract with a public relations agency. Often, regional or state agencies produce materials appropriate for or adaptable to communities' specific programs. Some collectors also have promotional capacities or contract for it. But most are more likely to partner with the municipal government to deliver its professionally-prepared promotional materials.

INITIAL COMMUNITY COMMUNICATION

Community participation and buy-in early in the program design process can be pivotal and avoid later difficulties by:

- Ensuring that the messages to the residents are clear and understandable to people outside the recycling industry,
- Ensuring that the new large carts for the program will fit well with residents' available storage space or gates to backyards,
- Determining cart colors that increase public acceptance, and
- Recognizing residents' preferences for cart size choices.

Once the promotional theme is chosen, it should remain consistent throughout the program so that promotional materials can be keyed to the theme.

Initial Program Materials

The goals of an outreach program are to:

- encourage more residents to participate in the recycling program,
- increase the amount of recyclable materials they separate for collection, and
- educate them on how to properly prepare the materials that they separate for recycling.

By now, most residents have participated in other recycling programs and may not understand why a previous program collected different materials or why they may need to prepare them differently. The more that neighboring jurisdictions can create programs that are consistent with each other, the easier it is for residents to participate accurately. But clear communication about what is required for your program is still essential.

Describe the materials you want to collect in ways that will encourage residents to properly participate. For example, if you ask for "glass," residents will throw in drinking glasses, plate glass, and mirrors along with their bottles. If, instead, you ask for "bottles, cans, and jars," it is clearer to residents that you are interested in ***containers***, whether they are made of glass, metals or plastic.

Describe the types of fiber you want residents to collect and also what types you do not want. For example, you may tell them you want newspapers, bulk mail and corrugated boxes, but not pizza boxes or other food-contact cartons. If your program takes magazines and catalogs, make that clear to residents.

Use the terms the public uses to describe the materials you want. For example, the public calls all kinds of boxes "cardboard" and are not likely to use or understand the paper industry's terms of "corrugated," "paperboard," or "boxboard." Your processor needs to know the accurate industry categories in order to properly sort the materials for market, but the public just needs to know what to put in their recycling container.

However, many single stream programs find that they will recover more of the specific plastic types they want if they accept all plastic containers than if they tell residents to look for a #1 or #2 on the bottle. Your processing facility should be designed to separate the plastics you can market from the others. The recovered plastics percentage will be higher when the responsibility for sorting is on the MRF rather than the residents.

A Picture Is Worth A Thousand Words

Target messages to your specific community. Even within one community there is likely to be a wide range of different cultural or demographic features and each may require a different approach, although they should maintain a consistent theme.

Most programs find that simple messages that are picture-based, emphasize graphics and minimize text are most successful, and are also most versatile in a multi-cultural community. The first few words are critical to getting the public's attention for the rest of your message.

Humor, of course, can help convey a serious message to a larger audience and also make it more memorable.

Printed Communication Materials

Whatever the form and venue, printed materials need to ***balance how much material to get into a single document with how to attract readers and get them to read all the way through, while giving them "enough" information.***

For many audiences, printed pieces can hit the highlights and then refer readers to more detailed information from another source, such as the recycling program's website or a call-in line. But the details that are most important for them to know need to be in the printed piece delivered to them.

Printed materials should stress the need for quality, so that the recovered materials can be made into new products that will be purchased by consumers. And, of course, the educational materials should model closing the loop by using paper with recycled content.

Other Communication Methods

Many community recycling programs have been extremely creative in finding ways to advertise their program and educate the public about how to participate while keeping costs under control. Examples include:

- **Electronic media** – TV spots and radio ads run as public service messages; interviews with the mayor and/or recycling program director about the start-up, enhancement or success of the program; public access TV
- **Print media** – Public service ads in newspapers, local magazines and shoppers guides; interviews and articles about the program
- **Outdoor advertising** – Bus banners, bus shelter ads, billboards
- **Other community advertising and education** – Movie theater pre-show advertising; promo videos made specifically for the recycling program to show in local venues; schools and kids' events; educational facilities at the MRF; community art contests and displays with art and sculptures made from materials collected in the recycling program
- **Recycling program** – Multi-color pictures imprinted directly into the collection carts, decals and labels on the collection carts, ads and signs on garbage and recycling trucks, inserts in customer bills, refrigerator magnets, recycling guide brochures, instruction cards that can be attached by magnet or adhesive backing to household appliances or cupboards
- **Internet** – Recycling program website
- **Newsletters** – Highly graphic with colors and designs consistent with the program's promotional materials. Some use mascots or historical tie-ins, Q&A columns, activities for kids. Include a phone number and e-mail address so that readers can get questions answered and provide feedback.

- **Participation in public events** – festivals, parades, neighborhood special events, Earth Day, puppet shows, local and state fairs

Communities should use different types of approaches to appeal to a wide range of audiences and incentives for recycling.

MEASURING PROMOTIONAL EFFECTIVENESS

Measuring message effectiveness not only evaluates the success you have had, but also illuminates refinements needed to improve the program. Some measurements include:

- How many messages were created and disseminated in each medium? Were they targeted to the community sub-groups most likely to absorb information in those formats? Are there other formats that could reach parts of the community more directly?
- How many households did the messages reach?
- How many times was each household likely to hear or see the message(s) and in what combination of media?
- How many tons of recovered materials were set out for collection before and after the message was delivered?
- Is there a change in the contamination rate after information is distributed, both in the case of general media over a particular area and also with one-on-one tags providing feedback on individual set-outs?
- Did more customers call in with questions or comments?
- Did the collection company notice differences in customer service requests?
- Did the messages work better with some segments of the population than with others? Why?

Build A Feedback Loop

Residents need to know how well they are doing. You should tell them when their participation needs improvement and how to do it. You can also applaud them for doing it right. While these two approaches can be combined, they are independent of each other.

Residents who are doing a poor recycling job need to be identified and educated in a way that encourages their continued participation. This is particularly important in a single stream program because contaminants mixed into the recyclables undermine the MRF's processing, especially when it relies heavily on equipment to sort materials.

Types of feedback loops:

- **Identification and Correction of Problems –** Depending on the system used, the collection company may identify and tag or log inappropriate set-outs so that someone can follow-up with these residents. There are many options for notification. Tags left on

recyclables that are not picked up are more likely to be positively received if they tie in visually with the other recycling program than if the tag that looks like a parking ticket.

- **General News about Program Successes –** Provide information to residents through electronic media, newsletters, and bill.

- **Rewards for Good Quality –** Rewards can encourage residents to take more care with quality as well as encourage more to participate. For example, Philadelphia's RecycleBank records online credits that residents can spend at participating local stores. Berkeley, CA recycling participants could qualify for cash rewards. Chula Vista, CA's residents might find a tag on their recycling cart thanking them for making their town a better place to live.

CLOSING THE LOOP

The public – indeed, even many recycling professionals –think that collection is "recycling" because, to them, it is the most visible part of the system. The public education program should include the message that recycling isn't complete until the materials that are collected are made back into new products. Encourage the public as well as local businesses to help their community recycling program close the loop by making sure the products they buy include recycled content.

ONGOING PROMOTION AND EDUCATION

While promotions may be used to make a big splash at the beginning of the program, it is important to continue to promote the program on an on-going basis. People need to be reminded on a regular basis about the recycling program, and continually provided with fresh information. New residents come into the community and need all the introductory information to learn how to participate.

The promotions budget should be large enough to adequately reach the residents and maintain the quality of the recovered materials. If quality starts to slip, it's time to increase program promotion and public education activities.

You can never do too much promotion of your recycling program. Follow the advertising adage to promote your program "Early and Often"!

PROMOTION BEST PRACTICES

Local governments are best able to match the promotional materials to their goals.

Target messages to your specific community.

Most programs find that simple messages that are picture-based, emphasize graphics and minimize text are most successful.

Balance how much material you put into a single document with attracting readers, while giving them "enough" information.

CHAPTER 6: COLLECTION SYSTEM DESIGN

INTRODUCTION

Collection is the part of the recycling cycle that is most visible to the public and to most community recycling program staff. This leads many people to believe that collection ***IS*** recycling – when it is actually only one part of it. Most people do not recognize that the recycling cycle is not complete until the collected materials are made into new products at a manufacturing facility.

COLLECTION SYSTEM CONSIDERATIONS

This chapter discusses collection programs in which all recyclables are collected together in one compartment on a truck. Since single stream recycling was initiated by the collection industry to increase the efficiency of their operations, fully commingled collection has come to symbolize the system.

The quality of the collection program is critical to getting those materials to a manufacturer in a condition that will produce high quality products.

In order to make this collection system work well, all of the participants – local government, the collection company management, and the company's drivers – need to understand what is expected of them. Their cooperation is key to optimizing the collection of recyclables.

COLLECTION VEHICLES

An almost infinite number of collection vehicle design features are available. One of the first questions for a community to answer is whether recyclables and garbage will be collected in a single truck with two compartments or in separate trucks dedicated to only recyclables or only garbage.

Sometimes the decision is made to use a split body truck to reduce the number of collection vehicles that travel on residential streets. While this is a worthy goal, it may actually make the collection system less efficient. Some problems that may result when recyclables and garbage are collected in a single truck include:

- Some of the recyclables may become contaminated by garbage in the loading process.
- The compartments may fill up at different rates, causing the driver to have to leave the route before it is finished in order to unload the compartment that has filled. If the travel distance is very great, the driver may be reluctant to make the extra trip and, instead, mix the materials in order to stretch the route.
- If the garbage and recyclables are to be unloaded at geographically separated locations, the collection vehicle may need to travel some distance after unloading the first compartment. This can result in the truck load not being properly balanced on the trip to the second destination, which may create roadway safety hazards and result in accidents. It also may cause higher wear and require more maintenance to the vehicle.

Best practices in collection systems favor collecting each separate category of materials (recyclables, garbage and plant trimmings) in separate trucks.

When loading a truck dedicated to only one type of collection category, the driver does not have to make decisions as to the operation of valves and levers that might contaminate one material type with another in a dual-compartment truck. Separate trucks also avoid spillage of one material type into the other compartment, which happens even in the best-engineered vehicles.

In single-compartment vehicles, there is never the possibility of one compartment filling up before the other compartment, as there is in dual-compartment trucks. Additionally, at the end of the route, the driver only has to unload the truck at one location.

If more than one load of recyclables will be collected each day, the driver should be required to return to the processing facility and unload the truck after completing not more than 60 percent of the total route area. This will reduce the compaction of the load, allowing the materials to be processed into higher quality commodities. It also reduces fuel consumption and wear on the truck, thus reducing maintenance.

If split-body trucks are used, it is important to calculate the relative proportions of the materials that will be collected and loaded into each compartment, before the trucks are ordered, so that each compartment will reach capacity at about the same time.

AUTOMATION

One of the most important features driving the shift to single stream collection is the opportunity to automate the system. In fact, many argue that most of the benefits claimed for switching to a single stream system actually result more from the automation than from commingling recyclable materials.

Benefits

A number of advantages are credited to automated collection:

- Both semi-automated and fully-automated collection systems reduce worker injuries from lifting accidents, which also reduces medical costs, worker compensation claims, and lost work days.
- Fully-automated systems allow service to a larger number of households since the driver does not lose time exiting the truck, connecting the cart to the dumping mechanism, and then re-entering the truck.
- Lidded carts keep paper dry on rainy days, and reduce litter from materials blowing out of the container on windy days.
- The use of 96-gallon carts in automated systems allows residents to save more materials before setting the cart out at the curb for collection. Collecting more materials from fewer stops increases efficiency.

- A wider, gender- and ability-neutral pool of applicants can be hired as drivers because operating a fully-automated truck does not require heavy lifting.

- With both semi-automated and fully-automated collection, recycling carts can be larger and are usually on wheels, encouraging residents to separate more materials for recovery and making it easier for residents to get them to the curb.

Over the life of a collection contract, the operational benefits and related cost savings can easily exceed the cost of the purchase of new carts and collection vehicles.

Additionally, while labor expenses are on-going costs of operating the system and will increase through the term of the contract, equipment purchases are depreciated at a fixed rate through the term of the contract.

But not all single stream programs find automation to be their best choice. Among reasons they may not opt to automate, or may develop only a semi-automated system, are:

- Carts for collection of recyclables may be too large for many households to store in some densely-populated neighborhoods.

- Localities with heavy snow may find that there is no available curb during several months of the year to line up carts for automated collection and carts left out overnight might be buried in snow.

- Wheeled carts may not be stable in hilly terrain, and there may not be room to collect them on narrow streets.

Some potential drawbacks to wheeled carts should be addressed in designing collection programs:

- When residents pay for all waste management services on the basis of how much garbage they put out (often known as “pay-as-you-throw” or PAYT) and the recycling carts are much larger than the garbage carts, excess garbage may be dumped into the recycling carts.

- The wheeled carts are much larger than the recycling bins in a traditional source separation program and some homes may have difficulty finding storage space for them or fitting them through backyard gates.

CONTAMINATION ISSUES

Automation and the use of lidded carts can also affect contamination levels in the recyclables.

In order to prevent contaminating all the other materials already in the truck, at locations where the recyclables are regularly contaminated, drivers should be required to look at the materials in the cart before they are loaded into the truck, and refrain from collecting contaminated materials.

Alternately, the route supervisor can stop at these locations before the collector gets there, and tag the contaminated carts, so the driver will see the tag and not collect the cart. In Chula Vista, CA, the cart contents are inspected by the ‘Recycling Rangers’ instead of route supervisors.

Collection contracts for fully-automated systems should require the collection company to develop methods for monitoring the quality of the materials in collection carts. Examples include mounting a mirror above the hopper, or installing a closed circuit camera above the hopper and a monitor in the cab.

When a new contract begins, or when new employees are hired, the program operators should educate employees in detail about the expectations for keeping the recovered recyclables free of garbage and other contaminants, and for maximizing recovery of recyclables.

The driver should be required to observe the materials as they are dumped and either leave a "notice of improper set-out" attached to the cart when a contaminated load is spotted or log the infraction on a reporting sheet in the truck for further company follow-up with the resident.

Collection vehicle operators should be required to identify repeat offenders so that route supervisors can check the bins or carts at locations that have been tagged more than once in the prior three months.

Drivers should be required to turn in copies of non-collection notices or notices of improper set-out.

If there are on-going problems with contaminated loads, the collection company should station a route supervisor at the processing facility to observe the trucks being unloaded and discuss the reasons for the problems with the driver.

COMMUNICATION

It is important that each part of the recycling cycle include a feedback loop.

- The Recycling Program Manager should communicate with the community's residents about how they are doing overall and what their recycling program is achieving.
- The drivers should communicate with the residents in their route area about individual set-outs.
- The route supervisor should communicate with the driver on the quality of the collected recyclables.
- The processor should communicate with the drivers, route supervisors and the collection program operators about the quality of collected materials delivered to the MRF.
- The processor should discuss the quality of its recovered materials with the manufacturers that bought them. Both the processor and the manufacturer should report on shipped materials' quality to the community Recycling Program Manager.

The processor should provide feedback to the collector on the rate of three different types of contamination:

1) Materials that can be recycled, but are not part of the current collection program,

2) Materials that cannot be recycled and should not have been collected, and

3) Materials that were recyclable, but are contaminated during collection.

COLLECTING GLASS

Unlike most other commonly recyclable materials, glass bottles are breakable. Glass that is broken into small pieces can cause extensive wear on the collection vehicles, and can cause damage to the equipment at paper mills and plastics manufacturing facilities.

In addition, when glass is broken at this early stage in the system, the pieces may become so fine that it is no longer possible to remove the contaminants that prevent glass bottle manufacturers from reusing the glass to produce new bottles. The result, then, is that much of the glass instead is diverted to low-value uses such as roadbed base and landfill cover, when it could otherwise been recycled repeatedly into higher value uses.

Preventing glass breakage starts with the collection truck. The glass is broken when it is dumped into an empty metal-bottomed hopper. But if the hopper is not emptied completely each time the packer blade clears its floor, far less of the glass will be broken en route.

To reduce glass breakage in the packer truck, strips should be added on each side of the bottom of the packing blade to raise it so that it will leave a layer of paper in the bottom of the hopper each time the packer is cycled.

COLLECTION COST ISSUES

Most of the savings from single stream programs are concentrated in the collection part of the recycling system. But, ***because commingled collection requires more sophisticated processing, a significant portion of those collection savings must be invested in the MRF in order to ensure high quality materials for recycled product manufacturing.***

The cost of separate collection systems for recyclables and garbage compared to collecting both materials in one dual-compartment vehicle varies depending on a number of factors, including:

- What types of recyclable materials are collected,
- Where the processing facility is located relative to the collection routes,
- Where the disposal site is located, and
- Where each of the material types are unloaded relative to each other.

These can be managed to produce the best cost plan to support a high quality recycling program.

SUMMARY: BEST PRACTICES IN COLLECTION

Local governments should specify as completely as possible the standards they want from the collection company and route drivers.

Collection programs must make performance an important condition of continued employment for drivers. Collection companies must identify those activities that are most important and then build them into worker training.

Recyclables and garbage should be collected in separate trucks.

Collection contracts for automated collection systems should require the contractor to develop a system that allows the driver to see the materials as they are dumped and to require drivers to refrain from loading contaminated materials.

The collector should be required to tag inappropriate set-outs and identify repeat offenders so that the collection supervisor can follow up.

The collection company should take steps to minimize glass breakage in the collection truck.

If there are on-going problems with contaminated loads, the collection company should station a route supervisor at the processing facility to observe the trucks being unloaded. The supervisor should discuss the reasons for the problems with the driver.

It is important that each part of the recycling cycle include a feedback loop.

CHAPTER 7: PROCESSING SYSTEM DESIGN

INTRODUCTION

In a single stream program, the processor must be able to sort back into their individual component categories the materials that were commingled by the residents and the collection process, in order for manufacturers to then use these materials to make new products.

The key to designing a new processing facility, or evaluating whether an existing facility will meet a municipal recycling program's needs, is to begin with the end of the process in mind.

At the earliest possible time, both the processor and program staff should interview representatives of all available markets to determine the quality standards they require. This should include the actual manufacturers that will use the materials, not only brokers who sell the materials. Each type of paper mill, for example, has different requirements. Mills making newsprint, corrugated boxes, tissue, or paperboard each require different types of fiber bales. What is good fiber for one type of mill may be a contaminant for another type of mill.

Recovered paper (e.g. newspapers, magazines, bulk mail, and boxes) accounts for 75-80% of materials collected by many curbside programs. Recycling programs should ensure high quality materials for paper mills while maximizing recycling quality for other materials, as well.

The processor's ability to properly prepare materials for use by each of the manufacturers is key to the vitality of recycled product manufacturing. That vitality, in turn, assures continued strong markets for materials recovered by community recycling programs. Discussions with market representatives should continue and be ongoing throughout the life of the contract to ensure that the standards are being attained and maintained.

The best practices in processing system design depend on the types of materials the MRF processes, the requirements of the collection programs it serves, and the needs of its end-markets.

A single stream MRF should be designed to:

- ***handle commingled recyclable materials and receive only the types and amounts of materials it is designed to handle,***
- ***handle contaminants and non-targeted recyclables,***
- ***prevent further contamination of recyclable materials,***
- ***process no more material than it can handle appropriately with the equipment and staff provided, in the time provided,***
- ***process the materials in a sequence that will maximize the quality of the recovered materials,***
- ***maintain the appropriate burden depth on conveyor belts to ensure quality sorting, and***

- ***ensure that the number of workers and the processing lines are adequate to handle the flow of materials received.***

Almost all the serious problems found in single stream processing can be traced back to operators not heeding one or more of these rules.

DESIGNING THE PROCESSING SYSTEM: DESIGN ISSUES

The ideal opportunity to match the best processing system to a single stream community recycling program is when a new MRF is being designed. Then the processing design can optimize specific goals and characteristics of the program and its markets, as well as incorporate the most up-to-date equipment.

But in the real world, many single stream programs either must retrofit an existing multi-stream MRF or share a processor with other municipal recycling programs. In that case, the municipal collection program may need to be designed to match the capabilities of the MRF, rather than expecting the processing facility to adapt to handling materials for which it was not designed. In some cases, the processor can install new equipment or change the design configuration to more closely match the municipal program, but this is not always possible.

Whether the single stream program will use a new MRF or an existing facility, there are a number of questions that must be addressed in order to evaluate how best to handle the program's recovered materials.

- ***What materials are in the loads that will be delivered from the collection program?*** A MRF designed for a specific range of materials cannot simply add new ones. Part of the system may need to be redesigned, new equipment may need to be installed, or the facility should not receive additional categories of materials.

- ***What is the percentage of each material?*** Understanding how much of the load will be fiber, what the percentages will be of each of the other types of materials, and what forms those materials will take (most can be expected to be containers) is important in making sure that there are enough picking stations, storage bunkers, and staff to properly separate each of the recyclable materials into marketable grades and remove contaminants.

Also, most MRFs today use star or disk screens to separate fiber from containers, but as more households shred their paper to keep the information confidential, more of the paper is ending up in the 'fines' that then need a different processing method to be separated for recovery.

- ***How much volume can be expected each day?*** The amount of materials expected to be received on an average day, and the difference expected on peak days, is critical in determining if the MRF's systems can properly handle the materials received. A new MRF should be designed for greater capacity than initially expected, both to allow the program to expand in the future and to prevent overburdening the system. An existing MRF should not receive volumes that exceed its capacity ratings and, in fact, volumes should always be below this ceiling to consistently achieve the highest quality.

- ***Are the loads consistent or do they vary by time of day, day of the week, or source?*** These factors may affect tipping floor area needs, mixed materials storage needs, worker schedules, and the amount of rolling stock (loaders) that will be needed. If more than one community recycling program uses the same processor, there may be wide

variation in what they collect and expect to put through the same MRF. Communities should require the processors to provide details of what will be received at the MRF.

- ***What types and amounts of contaminants are in the loads?*** Is the public well-educated about the appropriate materials to put in their recycling program, or do they "guess" – and often guess wrong? Remember that residents frequently want to recycle more material types than the program is designed to handle. For example, they are likely to include all plastics instead of only plastic containers, so the facility must be designed to remove both film plastic and other rigid plastics (such as toys).

- ***What condition are the materials in when they come out of the collection truck?*** Heavy compaction will make it harder to separate the mix of materials back into marketable commodities and may result in more broken glass.

- ***How wet is the paper?*** Carts or bins with covers will help to keep paper dry. A covered truck will keep out rain and snow. It is easier to process dry paper. If wet paper is not marketed quickly, it may degrade, resulting in a lower market value or even non-recyclability.

- ***How often must the processing floor be cleared?*** If too much material is coming in or the MRF is racing to clear its floor, the equipment is likely to be run beyond capacity, resulting in poor quality materials at the baler. Also, if the MRF is not able to get to the bottom of the pile of collected materials regularly, the quality of the materials there may degrade before they are processed. Every time the materials are moved, they are degraded.

- ***Is there sufficient space for storing material until it can be processed?*** Sufficient storage space can help prevent the urge to overburden conveyor belts and other equipment and allow consistent high quality processing even when truck deliveries are much heavier at some times than at others. The facility should have sufficient covered space for materials that are more difficult to process if they are wet.

- ***What are the intended end markets for the materials?*** Identify the intended markets for the recovered materials so the quality requirements can be determined in advance.

- ***What are the transportation options?*** Some markets may be close by, and others thousands of miles away. If the MRF is near a port, it will be more likely to sell to export markets. If it has a railhead, it may have access to more customers than if all its material must be trucked to market. Local markets may allow the paper to be shipped loose, saving the cost of baling it. Communities should identify local markets for the materials they recover. They should require their processors to provide details on their current market arrangements.

- ***Does the MRF operator have an existing market relationship with specific product manufacturers?*** Some MRFs have more than sales relationships with manufacturers. They may be owned by, or partners with, a paper mill. Or they may have a long-term contractual relationship with a recycling manufacturer to supply all of the materials it needs. Such relationships may suggest a higher likelihood of the processor meeting the manufacturers' specifications.

- ***Is the MRF flexible and adaptable enough to handle unforeseen problems?*** Even the best-laid plans do not always work out in reality. The MRF should be flexible enough to deal with these situations.

SITE DESIGN

The layout of the processing equipment and the sequence in which materials are sorted is very important to the overall quality of the materials marketed. No two MRFs are quite the same, but it is possible to provide a description of the processing at a typical facility.

Design Overview

1) Generally, as trucks arrive at the MRF, they are weighed to provide data on the amount of recyclables that are received. The material in the truck should be sampled to determine the composition, including the amount of "prohibitives" in the load.

2) The trucks then proceed to the tipping floor, generally a concrete pad, where the truck is unloaded.

3) Once the truck has pulled away, the recyclables are pushed up into a large storage pile using a wheeled bucket loader. This step often degrades the recyclables by mixing crushed glass into all of the materials in the load.

4) At some facilities, some prohibitives (such as hazardous materials like household cleaners), hard to process materials (such as wire and tires), and oversized items (such as large pieces of cardboard) may be removed from the load before the materials are pushed into the big pile.

5) The loader is then used to take recyclables from the storage pile and load them onto a conveyor belt that carries them to the first processing stations.

6) Most designs remove large items first, such as corrugated boxes, so that smaller items can be exposed for later sorting. In other facilities, workers often do the initial processing by picking selected materials off the belt as they come by. In more highly capitalized and newer facilities, screens are used as the first processing tools to separate the largest materials, such as boxes that pass over the disks, from other materials that pass through the openings in the screens (between the disks).

7) An increasingly common facility design is to smash the glass at the beginning of the processing system, as the materials flow onto the screens, so that most of the glass can be removed from the paper. However, this often makes it impossible to sort the glass to a high enough quality to be used to make new bottles.

8) The container stream is passed under a magnet to remove the steel/tin cans, then sorted by density to separate glass from plastic and aluminum cans. Once the glass is separated from the aluminum and plastics, it can be sorted by color using an optical sorter; and optical sorters can separate plastics by type, or separate plastics from other materials.

9) Small item fractions left on the conveyor belt are screened to remove the fines (tiny fragments of materials). They may become part of the facility residue, or they may be further processed to separate light materials (e.g. shredded paper) from heavier ones (e.g. glass, ceramics, rocks) so that additional recyclables can be recovered.

10) Garbage is either picked off the belt as a positive sort (if the load was relatively clean) or becomes residue that is allowed to go off the end of the belt as a negative sort.

11) Sorted recyclable materials are either baled to await loading into trucks for transport to manufacturers or to other facilities for further processing, or loaded loose into trucks depending on specific market requirements.

DEALING WITH GLASS

Most of the newest processing systems are designed to break the glass at a very early stage and then try to remove the glass from the paper. This works best when the processing lines are not overloaded but this system severely reduces the quality of the recovered glass. Best practices require developing a system that keeps the glass out of the paper and plastic while also maximizing recyclability of the glass.

When glass bottles are shattered in processing, the small glass fragments are scattered throughout the other materials at the facility. Not only does this make it very difficult to completely remove the glass from the paper, aluminum and plastics, but it makes it difficult to sufficiently clean the glass so that it can be marketed for bottle manufacturing. This problem may be eliminated if low-impact processing equipment is used to remove whole glass bottles from the collected materials before other processing is initiated.

The key to producing quality glass feedstocks is reducing glass breakage until after the contaminants are removed from the glass. Many of these contaminants cannot be removed once the glass is broken. When the single stream materials arrive at the MRF, there are some keys to maintaining glass integrity without compromising it or the other materials.

Best Practices in materials processing to recover glass include:

- ***Dump the load from the collection truck onto a softer, flexible surface such as a rubber belt rather than dumping it directly onto a concrete floor in order to reduce glass breakage.***
- ***Avoid pushing the received materials into a large storage pile with bucket loaders, in order to prevent crushing the containers that roll back down.***
- ***Get the glass out at the beginning of the processing system while the bottles are still whole or in large pieces, to the greatest extent possible.***
- ***Separate the breakable contaminants (Pyrex™, heat sensitive glass, ceramics and rocks) from the bottle glass before crushing the glass.***
- ***Avoid directing the commingled materials into hard, spinning discs and devices until the glass and other breakable materials have been removed.***
- ***Once the glass has been directed away from the other materials, sort it by color to increase its market value.***

SORTING MATERIALS

The most important feature in achieving high quality recovered materials is to avoid processing more materials than the equipment can handle. This means not overloading the processing lines. High quality recyclables can only be recovered when the processing equipment is allowed to do the job it was designed for.

Sorting Sequence

The specific sorting sequence may vary somewhat by facility, depending on the materials it processes and equipment it uses. But if the facility tries to process the materials outside of its specific design logic, the quality suffers.

Generally, it is best to separate large items from small items first.

A "pre-processing" area provides the best opportunity to remove items that may create a problem on the processing line (such as strings of holiday lights, garden hoses, or household hazardous wastes).

The presort area also provides an opportunity to remove any oversize items (such as large corrugated boxes) from the collected materials before other processing begins. This initial large-item separation is often done with manual labor at stations along the beginning of the conveyor belt. Recently some MRFs have added screens at the front end of the processing line to separate the largest items from the rest of the recyclables before other processing begins.

Removing problem items or splitting the streams by simple mechanical methods will allow the equipment to better sort each subgroup of recyclables. For example, an "air classifier" that splits the container stream into light and heavy components (separating glass containers from aluminum and plastic) produces a higher quality separation of the aluminum from the plastic than would be the case if sorting aluminum from both the plastic and glass still commingled together.

Depending on the markets available, a MRF may perform either a positive or a negative sort for each commodity. A positive sort removes the desired materials from those being sorted, while a negative sort removes only unwanted materials (contaminants), leaving the desired materials in the system.

Burden Depth and Belt Speed

A key to effective sorting is avoiding overloading the processing equipment. If material on the sort line is too deep, or if too much material passes by picking stations or equipment too quickly, it will not be sorted properly.

Many of the newer systems have added equipment to control burden depth and meter the materials on the processing lines.

To spread material out on the process lines, each conveyor should move faster than the belt before it. So, for example, if the first belt moves at 30 feet per second, and the second belt moves at 60 feet per second, then there is only half as much material on any one spot on the belt.

Equipment manufacturers rate their equipment on the basis of sorting under optimum conditions, so they present maximum capacity numbers. However it is not realistic to expect that the MRF will continuously operate under these conditions, so the community may want to plan to have 20%-25% more capacity than the rated throughput to insure that they are able to properly handle the materials received.

THE END OF THE PROCESSING LINE

Material that has been separated by commodity type may go directly to a baler or be loaded onto a truck for delivery to market. Frequently, however, it passes through an intermediate temporary storage area, including bunkers, bays, hoppers or debris boxes.

There are times when it is beneficial to send processed materials back through the sorting lines again in order to clean them to a higher quality level.

Partially sorted materials also may be shipped to other facilities for further processing, such as glass to beneficiation plants, plastics to facilities that can sort by resin type, and paper to facilities with optical scanners to sort by grade.

Cross-Contamination

It is common at processing facilities for some clean, sorted materials to be contaminated by being mixed with other sorted materials. This may happen at the openings to adjoining storage bays or bunkers. As the material in one is being moved by loader, some spills over into the other. It also is common when operators change from baling one material type to another.

When facility-induced contamination occurs, the materials should be returned to the sort line to clean them up again.

Residue

The purpose of processing at the MRF is to remove contaminants from the commingled materials while sorting them accurately back into clean feedstock streams for use by a manufacturer who will convert them into new products. Good program design and high quality processing should result in low residue rates.

Three types of residue are common at processing facilities:

1) "Contaminants" are materials that are not recyclable and were not supposed to be set out for collection as recyclables (also referred to as prohibitives from the collection system, such as garbage),

2) "Process residue" is material that is recyclable but not recovered by the processing at the MRF and is instead discarded to the landfill because it was not sorted sufficiently. It can also be materials that were recyclable when set out for collection but were badly contaminated during collection and processing. Process residue does not include non-recyclable materials ("contaminants") that may come to the MRF and then are disposed of in landfills.

3) "Market residue" is material that is shipped to a manufacturer that cannot use it. These materials are not discarded by the MRF, but are discarded by a secondary processing facility or a manufacturing facility. The extent of this residue should be included in quality reports from the manufacturer back to the processor and community program managers.

Often, much of the residue is broken glass, including 'fines' and glass that is too contaminated to be used by glass container or fiberglass insulation manufacturers.

Increasingly, residue also includes shredded paper, as residents become more concerned about personal security. Processors need to plan for that increased burden of shredded paper, and to be able to recover the paper, not send it off in the residue to the landfill.

Failure to follow best practices in processing is one reason for high residue rates.

Calculating the Residue Rate

The facility residue rate is generally calculated as the ratio of the amount of material that arrives at the MRF that is sent off to landfill for disposal, divided by the total amount of material received.

To correctly calculate the rate of each of the three types of residue, it is important to have data on the materials as they are received at the MRF, out of the back of the truck, before they are pushed into a storage pile. Processors should sample incoming loads to determine the composition, including the amount of "prohibitives" in the load.

The contaminants should be subtracted from calculation of the MRF residue because the MRF should not be responsible for managing the part of the residue that was not supposed to be collected in the first place.

Contaminants are the responsibility of the jurisdiction, which should design its recycling program and educate its residents to avoid contaminating their recyclables. Contaminants are not the fault of the processors that receive the collected materials.

But the MRF operators should be penalized for sending recyclable materials off to landfill or to the wrong manufacturers because they were not properly sorted.

Communities should require that processors receive reports on the quality of the materials shipped to each manufacturer. This includes the amount of inappropriate materials shipped to the mill. These tonnages should then be calculated as part of the residue rate. Copies of these reports should be provided to the local government.

DIVERSION

Many municipal governments regard the rate of diversion from landfill to be the standard for their recycling program. However, diversion does not guarantee that materials are being, or even can be, actually recycled into new products.

Best practices require that materials from each jurisdiction actually be recycled into the highest value product that is feasible.

Calculating the Diversion Rate

The diversion rate is calculated as the ratio of the total waste generated minus the total waste landfilled. So if a community generated 100 tons per day and landfilled only 60 tons per day, they would be said to have a diversion rate of 40 percent.

However, this might only indicate that, while the community was not directly responsible for landfilling the materials it considered to be "diverted," some of the materials counted as "recycled" may have been:

- Used to replace low value products (such as glass containers used as aggregate or road base), or
- Shipped to inappropriate manufacturers of new products (e.g. plastic bottles in bales of paper) and then landfilled by the mill.

To more correctly identify the real diversion rate and whether the contractor is meeting the terms of the agreement, communities should require their processors to conduct sampling at various points in the process, in order to determine:

- ***What percentage of the breakable materials (glass, ceramics, etc.) arrive at the facility intact,***
- ***What percent of and types of non-recyclable contaminants are in the load, and***
- ***What recyclable, but not targeted, materials are received. (This can suggest the need for more or better public education about the recycling program.)***

MULTIPLE-USER FACILITIES

When one MRF processes materials from several communities, it is hard to identify differences in received material composition and residue rate by jurisdiction, once all of the materials have been pushed up into one big storage pile.

From the individual community perspective, it would be best if their material were kept separate and processed by itself, but this is not practical in most cases.

Communities can require the facility operator to sample the materials received from their program and use the sample data to project the composition for the period until the next sampling is completed.

PROCESSING ISSUES

To recover the largest amount of material for the highest value uses, the processing line should be designed to recover each material type before it is degraded by the processing system.

The system should be designed to reduce the amount of recyclable materials that are incompletely processed, or that are re-mixed after separation, so that the materials shipped to market most closely meet the specifications of the mills to which they are shipped.

This means that the processor must reduce the amount of non-fiber materials shipped to paper mills, reduce the paper and glass contaminants in plastic bales, reduce the amount of organics (including paper) in loads of glass, and the community must reduce the amount of 'prohibitives' and other contaminants in the materials received at the MRF.

Capacity

Each processing facility is designed to handle a maximum tonnage of a specific composition of materials. Equipment capacity ratings are based on the ability of the machinery to process a product to a given standard. Ratings are generally based on ideal conditions that are rarely maintained for long periods of time.

However, a variety of factors may keep MRFs from achieving the ideal conditions. Capacity ratings are based on a consistent flow of materials, not an uneven distribution. So if the burden depth varies, a screen may function properly some of the time and not at other times. Additionally, if the screens become clogged by materials they were not designed to process, the screens will likely not perform as rated.

The best way to increase the quality is to reduce the tons processed per hour.

This can best be accomplished by running multiple lines, which also provides the facility some redundancy in case one line is down for maintenance. However, because of expense, many facilities have chosen to add additional equipment in the primary processing line, instead. Additional equipment can be added at any point along the line.

Recovered Materials Variety

MRFs that are designed to handle the materials collected by one program may not work as well in processing materials from another program. The new large facilities may receive widely different materials if they:

- serve multiple communities (potentially with different lists of targeted recyclables),
- serve different neighborhoods in large communities, or
- process both residential and commercial loads.

It is not realistic to expect a single processing system to do an equally good job of sorting materials from widely differing sources.

Many communities, especially smaller ones, have no choice but to share a processing facility with other programs. When different materials from different sources are mixed, it is no longer possible to track the quality from any one program.

Communities should:

- Match their targeted materials to the processing facility design,
- Avoid collecting materials that the processing facility is not designed to handle,
- Explore the potential for the processor to install new equipment or reconfigure the processing design to accommodate new materials,
- Require the facility to be designed with flexibility to handle very different streams of recyclables,

- Work with the other communities that use the same MRF to achieve consistency of program design across jurisdictions,

- Sample the loads from each participating community on a regular basis to see where each falls with regard to the average composition at the facility.

It is best to store materials from multiple collection programs in separate areas and process them separately and sequentially.

In some cases, especially if both residential and commercial materials are processed at the same facility, it may be beneficial to be able to introduce materials at multiple points along the processing line. So, for example, if clean loads of cardboard are received from businesses, it would be beneficial to be able to run them directly into the baler, and not have to run them over the full single stream processing line. Also true for loads of glass from bars and restaurants.

Additional Material Types

What if your jurisdiction wants to collect a larger variety of materials? It is not hard to imagine the chaos created when materials are collected that the equipment is not designed to handle. For example, when textiles or small electrical appliances are added to the system (as the City of San Jose has done), clothing or electrical cords wrap around star screens and render them useless by reducing the screen openings. When this happens, the sort line must be shut down and the cords and textiles must be cut away to allow the screens to work properly again.

If star or disk screens are to be used to separate materials, then the screens should be placed at a position in the line that is after the point at which problematic materials such as cords and textiles can be removed by other means, such as hand-picking by sorters or separation by another type of equipment.

Alternately, a facility that uses this type of equipment should not accept these material types – they should be excluded from the collection program. However, once a program has operated in a community that accepted these materials, it is difficult to "turn off the flow."

It is important to realize that in communities where glass is not collected at all, or where glass is collected separately, it is likely that some glass will still arrive in the single stream loads; and the facility must be designed to accommodate this condition.

Commercial Collection

Single stream started with residential curbside collection, but now some programs are expanding it to collect materials from commercial sites. Often the majority of materials from these sites are homogeneous and close to the quality that a manufacturer would want, e.g. glass bottles from restaurants or office paper from businesses. It may be more effective to collect this material separately, when a full load of a single material type can be collected in an efficient route. Then, these recyclables should be processed separately, and not run thorough the entire process line, in order to minimize contamination and maximize high quality and ease of marketing. Some facilities are able to deliver this type of uniform material to bunkers at the MRF rather than adding it to commingled lines, or may process it on a separate line or at a different time from the commingled materials.

PROCESSING COST ISSUES

Processing costs money! It takes time, labor, equipment, space, utilities and a facility. Processing costs must be balanced against the additional value derived from the more highly processed materials. But to achieve the program goals of the local government, materials should be processed to the quality standards desired by the community, not necessarily to the level of quality that achieves the lowest cost.

The costs of processing vary widely based on different design options. The design features that work best vary by community, based on the types and composition of materials collected and how much processing equipment and labor are used. Labor requirements also vary by individual situations, including the types of materials processed, kinds of equipment used, and sources for the labor pool.

Some MRFs have tried to reduce labor costs by hiring fewer workers or employing people who are developmentally disabled or serving community service sentences, but most processors have then abandoned the practice. Their experience indicates that often these labor sources are not really less expensive because of the overhead costs connected with them. Also, the inconsistency in the workers' ability and availability on any given day, makes it difficult for MRFs to produce consistent quality feedstock materials. Generally, operators have found that it is better to train and use a secure and stable workforce.

Overall, the per ton processing costs are higher for small facilities than for large ones. The greater the number of tons processed on the same equipment, the lower the unit processing costs. Doubling a MRF's capacity does not double its operating costs. Small facilities may not process sufficient tonnage to amortize the equipment costs. Some smaller facility operators recognized that high tech equipment does not make economic sense for their program and have therefore elected to maintain dual-stream programs, in order to sustain the integrity of the recovered recyclables.

Some portion of a MRF's costs are fixed over the length of the contract. Equipment costs are generally depreciated as a monthly expense. Labor, however, is generally perceived to be a variable cost. In too many cases, processors spend on expensive equipment but then sacrifice the quality of the marketed recyclables by reducing staffing to "keep costs down."

What is required, instead, is looking at the whole system cost necessary to produce high quality recyclables. This is why it is important for the community to set the quality standard that the processor must achieve as a condition of the contract, to ensure that high quality is part of the "cost-effective" equation.

Program Revenues

Revenue from sales of recovered materials is highly variable. It is dependent in most instances on the international marketplace and the value of the processed materials to the manufacturers who make new products from these materials.

Some municipal recycling program contracts provide incentive payments to processors if certain targets are met, while some also include economic penalties if certain conditions are not achieved.

Even though current materials processors are able to sell most of the materials they produce, a large percentage of MRFs are not meeting the quality requirements of the manufacturing

industries that are buying the recovered materials from them. The processors, however, say they see no reason to process materials to a higher level since the buyers will pay for the materials "as is."

Many processors consider processing to a higher quality level to be a waste of money, since in many cases it does not increase their revenue. While companies that run processing facilities understandably are focused only on their bottom line, this is not a sufficient driver for the larger recycling system. Municipal governments should recognize that the bottom line is only one part of the interdependent system.

Communities should require that the facility handling their materials meet these higher standards in order to ensure that manufacturers have sufficient quantity and quality of recovered materials to maintain their current recycling investments and invest in new and expanded capacity. This sustains and improves the health of the North American recycling system.

Residents commonly believe that the newsprint they put out for recycling comes back to them as new newsprint, and that old bottles become new bottles. Communities must identify whether they wish to match the expectations of their residents, and the quality to which they want their recyclables processed, and require that their processor meet at least that level.

SUMMARY: BEST PRACTICES IN PROCESSING

Begin with the end of the process in mind. Know what the processed materials will become.

Interview representatives of prospective markets to determine the quality standards they require. Continue these discussions throughout the term of the contract.

Design the facility to handle likely contaminants as well as the targeted recyclables.

Receive and process only the types and amounts of materials the MRF is designed to handle.

Examine the incoming materials to provide feedback to the collector and community, and to accurately calculate the facility residue.

Design and operate the processing system to produce high quality in all the materials streams without sacrificing one or more to benefit others.

Build the MRF with a greater capacity than required at the start of the program.

Maintain the appropriate burden depth on conveyor belts and screens to ensure quality sorting.

Employ sufficient labor to properly operate and maintain equipment, and to properly remove contaminants from the recovered materials.

Reprocess residues to maximize recovery of recyclables and minimize disposal.

Provide financial incentives to the processor to produce higher quality materials than may be rewarded by the open market.

CHAPTER 8: CONTRACTING FOR SERVICES

CONTRACTING OVERVIEW

Local governments drive the recycling system. They control the system by contracting for services. Contract provisions determine the recycling services to be provided and specify the results to be achieved.

Programmatic changes are easiest to implement when new contracts are negotiated, but changes can be made at any time in long-term contracts, if both parties agree to them. Service providers are generally happy to provide additional services if they are fairly compensated for the costs of those new services.

There is no single contract that is "right" for everyone. Each community must identify the contract features that best meet their program goals. Many different ways of financing recycling programs are available, and there are so many variations on relationships with collectors, processors and end-users that each contract must be individualized to a specific locality.

But there are details and specifications that should be included in each single stream contract, no matter what the individual circumstances. The following discussion presents some of the positive and negative results of different kinds of contract language.

CONTRACT SPECIFICS

Contracting for Collection

Communities should specify which materials are to be collected from the residents, what container will be provided for storage of recyclables at the residences, and what happens if the contractor does not meet the standards set for level of service.

Contracting for Processing

Communities should specify that they want materials produced to a high level of quality. Potential contractors will then factor the cost of this service into their bid price, just as they do for the rest of the system, to achieve the goals of the community.

In preparing a bid, the contractor should be required to describe existing relationships with buyers of materials that will be recovered in this program and provide references for each material type to be marketed. The contractor should also include in the proposal a set of specifications that were provided by the buyer of the material.

The materials specifications should include information on allowable and unacceptable contaminants and residue rates. The contractor should provide definitions and rates to be achieved for each contaminant and residue type.

The community should specify that contaminants in marketed materials are to be kept to a minimum and must meet the specifications of the buyer of the materials.

At the start of a new contract, a municipality may be in the fortunate situation of being able to design a processing facility from scratch to match its program. In this case, the community

should specify how the recovered materials will be handled and the quality of the recovered materials sent to market. Then the community or contractor can design a facility that will achieve the specifications set by the community.

Specifically, the community should work with their contractor to identify available markets for each of the commodity types to be prepared from the mix of recyclables to be collected. Once the markets have been identified, the community should determine the quality specifications for those materials. Based on the market specs, the community would then work with equipment designers and manufacturers to obtain a system that will achieve the desired results.

Quality Specifications Example: *Contractor shall process the materials collected to the specifications established by the community and the buyer of the recyclable materials.*

The Contractor shall pay the community $20.00 for each ton of recyclable materials sold to a manufacturer that does not meet the quality specifications.

The processing contract should specify the terms of processing, and include:

- ***Specifications on types, composition and quantities of materials to be collected***
- ***The hours of operation of the processing facility***
- ***The commodity types to be processed and marketed***
- ***The quality of each of the commodities to be marketed***
- ***Details on how the recovered materials will be marketed***
- ***Details on what staffing and equipment levels will be required to meet the market specs requested by the community***
- ***Mechanisms to adjust equipment and staffing levels as tonnage changes***
- ***Allowable residue rates from recyclable materials not marketed (the residue from non-recyclable materials should not be counted against the processor)***
- ***Remedies for correcting problems in the processing facility***
- ***Resolution for disputes over the quality of the incoming materials***
- ***Requirements for maintaining records of materials from each community served by that facility***
- ***Penalties for not achieving the required product specifications***
- ***Incentives for exceeding the required minimum product specifications***
- ***Other specifications as appropriate to local conditions.***

It is important to be able to distinguish the actual costs of the processing services. Your community may be contracting with a collector who also owns the processing facility or has an existing contractual relationship with one. In that case, the community should require the contractor to provide information on the costs of each of these services.

This is best done with an audit of actual expenses incurred. Communities are likely to best be served by paying an amount agreed to as fair for the first year and requiring that, at the end of one full year of processing, the processor demonstrate actual costs, with future payments to be based on that amount. The community could deduct any overpayment incurred in the first year from future compensation (or alternately make up any short-fall in payment to the contractor).

Communities should ensure that they have adequate controls in place to manage any problems that may arise from their collectors' subcontracted relationships. The community should review the contract between their contractor and all subcontractors to ensure that they meet the community's needs.

It will be important to have the contractor report items that are specified in the contract, including:

- Number of tons received,
- Number of tons of prohibitives and residue disposed, and the composition of the prohibitives and residue,
- Report on the markets for each commodity, with letters stating if the quality specifications are being met, and
- Staffing levels for the period.

If your processor handles materials from more than your jurisdiction, you should require them to provide a plan to ensure the accuracy of data and how that plan is to be implemented. This could include their conducting additional sampling of your materials and that of any other jurisdiction from which they receive materials, so that they can account to all jurisdictions why there are any changes in the cost of processing, or in the facility residue rates.

COST IMPLICATIONS

Processing recyclable materials to higher quality may cost more than processing to a lower quality, but will result in higher revenues to off-set some of these increased costs. The actual balance will depend on which materials are processed and what the available markets will pay for them. In some cases, the total cost of the program may be lower when processing produces higher quality materials and in other cases, the opposite may be true.

The community should not expect the processor to reduce their profits as a result of this added cost. In those communities where profits are based on the cost of providing the services (operating ratio contracts), the contractor may actually increase their profits by processing to a higher level.

If you are changing services to single stream during an existing contract and need to negotiate the "additional" processing costs with your contractor, you can require that they demonstrate

the actual costs after one full year of processing the new material mix and adjust the amount paid to match their acceptable costs.

Local Markets Incentives

If there are local manufacturers that communities want to support for economic development reasons, the contract could include language to allow the community to direct the materials to a market of their choice and provide community compensation to the contractor for any revenue loss that the contractor could document (adjusted to deduct the cost of transportation savings).

CONTRACTING FOR PROMOTIONS

Communities should hire a professional promotions firm to promote their recycling program, if they do not have this expertise in-house. In most cases, the local government is in a better position to educate its residents and reinforce the messages than collectors and processors.

In most cases, the collector should not have the primary responsibility for developing the promotion program. However, the collector should be required to help promote the program through distribution of printed materials, checking the contents of the garbage and recycling carts, and sending messages on or in with the customer bills.

If you do, however, decide to make the contractor responsible for the promotion program, there are two approaches you may wish to consider. First, the community can specify exactly what promotional materials are to be provided, and require that the contractor fulfill the obligation of implementing the activities specified by the community. Alternately, the community can require the contractor to provide the community a promotional plan, with drafts of each communication as the program goes along, for community approval prior to its distribution.

CHAPTER 9: SUMMARY

Advances in collection efficiency that have introduced single stream concepts to community recycling programs must now be matched by corresponding advances in processing capabilities. Recyclables are resources that should be used to their maximum and community collection programs should be considered Resource Management Systems, not management of wastes.

The focus should be on returning resources to manufacturing in order to reduce the need for extraction of raw materials and obtain related benefits such as reduced use of energy and water and reduced pollution.

Local governments, responsible for implementing community recycling programs, have both the responsibility and the authority to consistently drive the system to its highest potential. They should insist that their collectors and processors handle recyclables as resources and commodities to be processed for reuse, not as materials to be diverted from landfills.

Program design and contracts for services should reflect all parts of the recycling system, not just collection. Recycled product manufacturers should be brought in to feedback loops to ensure appropriate processing system design and functioning.

It is in recyclers' best interests to support the quality of recyclable materials that will encourage further development of recycled product manufacturing opportunities, whether domestic or abroad.

Relating the community's goals to the entire system and ensuring that manufacturers receive high quality materials will assure the health of the recycling system now as well as long into the future.