Single Stream Recycling Best Practices Implementation Guide

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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-2011-028

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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 Implementation Guide, and the companion Single Stream Recycling Best Practices Manual.

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 Implementation Guide and the Manual. 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 Guide and Manual. There are too many to list, but we took all of the comments to heart in making the Guide and Manual 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 manufactures 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 and Implementation Guide 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

Recycling is a dynamic system that is continuously 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 efficiencies in the form of single stream recycling programs. Processors have, in turn, made essential, corresponding adaptations to their equipment and facilities.

But, while the advantages of single stream collection programs have been driving hundreds of U.S. and Canadian communities to embrace single stream recycling, the problems it can create have yet to be adequately addressed and resolved. Instead, the necessarily collaborative nature of the overall recycling system has been fraying.

Local governments are in the best position to provide the broad vision and incentives to ensure a highly-functioning system. Yet often they do not realize how critical it is that they provide this leadership and what is at stake.

For recycling to thrive and grow, all participants must build their individual successes within the context of the whole recycling system. Business success is the means, but resource conservation and environmental quality are the purpose for ensuring a healthy recycling system in the U.S. and Canada.

This Single Stream Recycling Best Practices Implementation Guide, and the companion Single Stream Recycling Best Practices Manual, are dedicated to identifying solutions to the problems created by many current single stream recycling program practices. The goal of this Guide is to help communities with single stream recycling programs use their leadership to optimize long-term recycling development by getting the best possible services that produce the highest quality materials for use in manufacturing new products.

INTRODUCTION

Recycling Changes

Modern community-based recycling collection and processing programs began in the 1970s in a number of innovative towns and communities. More municipalities followed suit throughout the 1980s. Following the wayward voyage of the Mobro Barge, states and local governments enacted legislation to encourage more recycling. Now more than 9,000 communities offer their residents curbside collection in the U.S. and Canada.

But recycling did not begin with these programs. For centuries, manufacturers have reused production scrap. Entrepreneurs have long made successful businesses out of collecting trimmings from printers, paper converters, and corrugated box-making factories as well as from manufacturers making cans and bottles, in order to sell them to manufacturers to make new products.

The early waste management collection companies often proudly included the word “scavenger” in their name, since they scavenged for reusable and resalable materials. Organizations such as the Boy Scouts joined scavengers in picking up old newspapers, used boxes and discarded glass bottles from neighborhoods, churches and schools and selling them for profit to brokers and manufacturers. The early 1970s municipal recycling programs were designed to expand on this already-existing resource conservation and entrepreneurial framework.

As municipal recycling programs have evolved and changed over the past 30 years, each sector – collection, processing, manufacturing, and purchasing 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. Each sector must support the efficient functioning of every other part of the system or the recycling cycle breaks down. 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 the public.

As yet there is no common definition of "single stream" collection. Some programs collect a limited number of materials while others collect a surprisingly wide range. Some collect glass, some do not. Many are fully- or semi-automated, while others still rely on manual labor. Most introduce large-volume wheeled carts, but others stick with a bin system. Most favor large processing facilities to sort all of the mixed recyclables back into their component parts.

What they all have in common, though, is that they tell residents not to bother sorting their recyclables. Instead, residents are instructed to throw all recyclables into the same cart or bin for collectors to load into a single truck compartment and haul away 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

Most local governments that have switched to single stream are very enthusiastic about it. They cite advantages such as:

- Increased participation by residents. Recycling is perceived as being easier if people do not have to think about sorting before they recycle.
- Increased participation by small businesses and multi-family apartment complexes. Multiple bins for sorted recycling are a challenge in areas with high density or space constraints, especially in older downtown buildings or congested neighborhoods. Single stream reduces collection to one cart and consolidates what previously may have been small amounts in each of several bins.
- Increased amount of recyclables collected, often initially doubling previous rates although often eventually settling down to a 20-30 percent increase,
- Higher rates of diversion from landfills,
- Reduced collection costs,
- Reduced worker injury and workers compensation costs, and
- Potential for collection of additional types of materials such as green waste and food waste, often in new and separate collection programs that take advantage of reallocated collection truck capacity.

But, while single stream programs may increase convenience for the residents and reduce costs for the collection companies, they can also increase the costs and problems for processors and manufacturers. If the collected materials are not properly processed, the manufacturing sector encounters production obstacles created by:

- Poor quality recovered materials that they must use as production feedstocks,
- Reduced operating and energy efficiencies from poorly sorted materials that include many contaminants to their manufacturing systems,

- Dramatically increased internal costs because poorly sorted materials demand new and upgraded feedstock cleaning systems, increased maintenance, and more frequent equipment repair and replacement,

- Lost access to recyclables needed for manufacturing when they are sent to the wrong types of manufacturing mills,

- Increased raw material costs to replace those too contaminated to use, and

- Increased costs from landfilling unusable materials included in the bales bought to make recycled products.

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. Dual stream programs can also produce poorly processed materials that create problems for manufacturers.

Most of the recommendations in this Single Stream Recycling Best Practices Implementation Guide 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 Guide 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.

Single stream programs are not the best option in every area. Many local governments are happy with their source-separated system that allows them to maintain the high quality of the recovered materials while keeping processing costs down. Others are experimenting with improved dual stream systems. Some communities, including major cities such as Atlanta, incorporate thriving and successful drop-off systems into their recycling programs. Still others are pioneering wet/dry collection systems that eliminate the concept of “garbage” altogether.

Some smaller communities have found they cannot effectively pay for the added cost of processing equipment. Single stream programs tend to be most cost effective in major urban areas or when several jurisdictions join together to support one processor.

GUIDE TO BEST PRACTICES: 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. At the same time, their potential benefits are great, including for manufacturers, if the difficulties can be resolved.

The goal of this Guide 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 accurately separate out the mix of materials collected.
- Failure to include quality requirements for recovered materials in collection and processing contracts.
- Focus on foreign markets that can reprocess poor feedstock materials because their manufacturing facilities are newer, have more built-in processing equipment and can access cheaper labor.
- Lack of focus on the health and future of the entire recycling system.

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 met over the long term, however, if the problems created by current programs are solved. Therefore, all who currently benefit, or want to benefit, from conversion to single stream programs should actually have the greatest vested interest in resolving the problems. That is the only way that single stream recycling can fulfill its potential beyond the short term.

DEFINING THE DILEMMA

What Are The Problems?

Recycling businesses and community programs are all part of an interdependent cycle, a system in which the success or failure in one sector reverberates into all of the others. In such a situation, no matter how beneficial an advance may be to one sector, if it causes problems in another sector, it is a problem for everyone in the system – including those whom it initially benefits – until it is resolved.

This does not mean that the change should necessarily be abandoned. It does mean, however, that the change must be worked through the entire system so that each sector can adjust in ways that support their own success as well as the success of the whole system.

With most single stream programs, 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. Common problems include aluminum, plastics, and glass containers being included in fiber bales sent to paper mills, which not only creates problems for the paper mill but also deprives the other materials industries of the feedstocks they need. At the same time, broken glass and shredded paper in bales of plastic and aluminum create problems for those mills, and many contaminants sent to glass manufacturers cannot be removed from the recovered glass.

Because of the rapid evolution of single stream collection systems, the recycling cycle is becoming disrupted. Equipment manufacturers sell their sorting equipment to the processors, but neither works with recycling mills on designing or procuring processing equipment that meets their production needs. Communities' contracts with processors rarely include specifications for meeting manufacturers' requirements. Yet the contamination issues that face mills today are most often the result of processing for throughput, not for quality of feedstock materials to the mills, or because upgrades in processing capabilities have not matched the collection changes.

What Are Effects Of These Problems?

Recycled product manufacturers are critical to the ongoing success of local communities' 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 local collection and processing 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 programs if they want long-term success.

Specific Manufacturing Issues

While many types of recycled product manufacturers are facing difficulties in using single stream materials, the specific effects vary by the type of facility and the particular products they make. Within each material type there are significant variations, as well. The list of common problems is long.

Paper Industry

Single stream programs regularly report that paper fiber accounts for 75-80 percent of the materials recovered by curbside recycling collection programs, and even higher from office recycling collection programs. Fiber may be in the form of newspapers, magazines and catalogs, phone books, office paper, mail, containers such as milk cartons, and packaging such as cereal boxes or corrugated cartons. Each type of paper product is made in a different type of paper mill and each of those types of mills has specific, and different, feedstock needs.

This Guide is accompanied by a pictorial "walk-through" of the paper manufacturing process that shows many of the differences between paper mills. Some of the problems common to most paper mills that handle single stream materials include:

- Glass in the fiber bales endangers paper mill workers, is abrasive and damaging to expensive paper manufacturing machinery, and can end up in finished products.

- Glass, plastics and metals damage equipment, create product defects, and must be landfilled.

- Fibers incompatible with specific types of mills, such as corrugated boxes at a newsprint mill or old newspapers at a mill that makes printing and writing papers, can create product defects and, if they can be separated from the incoming materials, are usually landfilled.

- Production costs have increased significantly at many recycled paper mills because of higher maintenance and equipment replacement costs, landfilling inappropriate feedstocks, and buying more fiber to replace the materials that could not be made into paper. Individual mills report impacts such as more than 20% of incoming bales consisting of unusable materials and having to landfill more than 30 tons of materials per day that had been intended for recycling.

- Poor quality recyclable materials have produced defects in finished products. Manufacturers must meet tight cost and quality specifications in order to compete favorably with products made from virgin materials. When they do not, customers avoid recycled products, recycling mills lose customers, and manufacturers lose income from the defective products they had to scrap.

The problems created by poor quality feedstocks at a paper mill are not isolated impacts. Rather, problems that start with receiving poor quality recyclables cascade throughout the mill and the whole papermaking process. One paper mill engineer likened it to "death by 1,000 cuts." The following example tracks glass through a mill, but similar problems can be created by other inappropriate materials, as well.

Example: Following Glass Through A Paper Mill

- Glass that is embedded in the fiber bales delivered to a paper mill creates safety hazards for mill workers who handle the bales. They can be cut by pieces of glass and breathe in fine glass particles that are stirred up into the air when they offload and break open bales, work in fiber storage yards and warehouses, and deliver loose and baled fiber to the pulping unit.

- Glass that shakes out of the bales while the fiber is being trucked to the mill may embed into the next load shipped in the truck, such as finished paper backhauled from that same mill. Because much of the glass is so fine, even thorough cleaning of the truck before reloading cannot remove it all.

- When glass goes into the paper mill's pulper, some of it is removed by the action and screens in the pulper and is piped away for disposal. But some of it is so fine that it is forced through the cleaning screens, even though the slots in the screens may be no more than 1/6,000 of an inch.

- Pulp travels through many types and sizes of screens on its way to the papermaking machine. Glass grinds up the screens and makes the holes in them larger, reducing their effectiveness.

- The glass gets into all parts of the finely-tuned papermaking machinery, much of which costs tens and hundreds of millions of dollars. The equipment then requires much more frequent maintenance and replacement. Some of the equipment may need to be shut down during maintenance, causing the mill to reduce production.

- Many of the surfaces in papermaking equipment need to be completely smooth to make uniform high quality products that will later perform perfectly on customers' equipment. The glass scrapes and scratches these surfaces, requiring them to be resurfaced more frequently and increasing plant downtime while they are switched out.

- Glass can end up in the final paper products and damage equipment at printing and packaging plants. If customers risk damage to their machinery and products, they are likely to avoid recycled products.

- Customers who have bad experiences with specific recycled products are more likely to reject other recycled products, as well.

- Because mills that use recovered paper need so much fiber every day to make their products, even a seemingly small percentage of glass can add up to many tons each day. All this glass then needs to be disposed of. Mills end up paying much higher disposal and landfilling fees than if they received clean fiber to begin with. For example, one mill reported that they normally pay to empty their 30-yard roll-off once or twice a week, but when they used single stream materials, they ended up having to pay to empty it two or three times a day.

Some Differences Among Paper Mills

Because mills making different types of paper products use different types of equipment and processes, there are variations in the ways that poorly sorted feedstocks affect their facility. The problems, or the lack of problems, described by one mill representative often cannot be generalized to other parts of the industry. For example:

- Glass is a very serious problem for newsprint mills. But paperboard mills such as those making detergent boxes or cores for products such as paper towels can get most of the glass out of their system. They use a different type of pulping unit that cannot be used to make newsprint. (Of course, they still have extra costs for landfilling the glass and other non-fiber materials.)

- Many newsprint mills can handle most types of rigid plastics, although plastic bags are a serious problem. But paperboard mills find plastics to be a very difficult problem – again, because they use a different type of production system. Tiny bits of foam plastic, in particular, are almost impossible for paperboard mills to completely clean out of their system, but they produce pinholes in the finished paperboard if they get through the screens.

- Linerboard mills, which make the outer layers of corrugated boxes, cannot use newsprint or office papers to make their products because the fibers from these materials do not provide enough strength. Newsprint mills cannot use corrugated boxes, and printing and writing

mills cannot use either newsprint or boxes. But paperboard mills and those that make the fluted center of corrugated boxes can take a wide range of mixed materials.

Plastics Industry

The plastics industry, too, faces serious problems from the poor quality recyclables that have become increasingly common in single stream programs. The seven primary types of plastics represented by the chasing-arrows plastics numbering system actually result in over 15 material types for recyclers, if they are to be recycled into their highest value products. But because the cost of sorting plastics is so high, many may be combined to make lower value (mixed type, mixed color) products such as ocean pier pilings. While these are often excellent candidates for recyclable materials, they cannot be recycled again into new products and therefore short-circuit plastics' recycling potential if they are the first stop for recovered materials.

Some of the problems created for the plastics industry when recovered plastics are poorly processed include:

- Loss of the recyclables to paper mills that are needed for recycled plastics manufacturing. Once plastics have gone through the paper mill's pulping system, they are no longer appropriate for plastics recycling and must be landfilled.

- Glass mixed in with the plastic feedstocks. This produces higher processing costs and, if the glass is not completely removed, holes in the new products. It also produces problems similar to those in paper mills: worker hazards, grit that grinds up the manufacturing equipment, and increased loads to be landfilled.

- Paper fibers mixed in with the plastics. These are most likely to be small fibers and shreds, not larger sheets of paper, that increase the cost of preparing (washing and drying) the recovered plastic for reuse in new products.

Plastics manufacturers estimate that 39 million pounds of plastics were inadvertently sent to paper mills in one year alone because of poor sorting. With PET plastics, in particular, solving single stream processing problems is economically compelling. While the value of one metric ton of newsprint may be $125, the value of the same weight of PET is close to $550. In California, where containers earn a redemption value plus processing payments, that same metric ton can be worth more than $2000.

Glass Container Industry

Problems from poor quality recyclables in the glass industry include:

- Contaminants such as heat-sensitive glassware (e.g. Pyrex™) and ceramics, stones, rocks and dirt that can no longer be adequately removed once the glass is broken into small pieces. These fines are generally landfilled rather than recycled because the contaminants will cause imperfections in new bottles and jars.

- Organics and plastics that can cause problems within the furnace such as hot spots, as well as increased maintenance requirements. Some contaminants can cause the glass to froth, or vary, in color.

- Glass lost to the bottle industry because it was delivered in fiber bales to the paper mills, from which it must be landfilled. Once glass has gone through the paper mill's pulping system, it cannot be separated for recycling into new containers or other high value products.

- Contaminants received at the glass manufacturer and removed from the glass before it is sent to the furnace that must be disposed of at a landfill.

Metals

Metals must be separated into steel (which can be pulled off processing lines by magnets) and non-ferrous metals (e.g. aluminum, brass and copper). The steel industry is better able to recycle poorly sorted materials because magnets help it separate its materials from the contaminants. But other metals industries, such as aluminum, cannot do this and instead end up with increased slag, caused by glass that makes it into the furnace, which raises the cost of the smelting operation.

In addition, significant numbers of cans, especially aluminum, are lost to the metals recycling industries when they are so poorly sorted that they end up in fiber bales sent to paper mills.

Beverage Container Recovery Rates

In addition to the negative effects of shipping the wrong materials to a manufacturing facility, the calculated recovery rates for some of the materials, especially beverage containers, do not reflect their true recycling rate when they are collected for recycling but end up landfilled at a paper mill.

For example, California beverage containers that residents set out for recycling but that, instead, end up in poorly sorted fiber bales going to paper mills are not counted as "recovered" in the calculation of state recovery rates. Additionally, no redemption value is paid to the collector for them by the state's bottle bill program. (However, they are counted as "diverted" even though they are landfilled by the mill.)

Why Have These Problems Developed?

Many recycling programs' organization and focus have changed dramatically over the past two decades. Some changes have been efforts to institutionalize the programs and some have been intended to compel continually higher recycling rates. Along the way, as improvements have been made to one part of the system or another without regard to their subsequent effects, the overall understanding of recycling as a whole system has been lost as an evaluation guide. Some of the changes include:

- Increasingly, municipal governments have measured the success of their recycling programs by their rate of "diversion" from local landfills. Many even have legally mandated diversion requirements at either the local or state level or both. But little attention has been paid to what happens to recyclables once they are "diverted." The nature of many municipal recycling programs has shifted away from a focus on environmental benefits and resource conservation to a current focus on accounting for diversion.

- Too often, municipal governments' commitment to increasing local recycling rates has been interpreted as requiring maximized diversion at the lowest possible costs. This shifts the recycling focus to collection of the maximum volume without regard to the cost of processing, creating a disconnect between municipal collection programs and the ultimate fate of the recovered materials.

- Collection companies are able to propose and implement cost-saving efficiencies for their sector of the recycling cycle, without always including corresponding, adequate adjustments to the processing system. If recyclables are mixed in collection, more expensive and sophisticated processing is required to sort them back out into separate materials at the MRF.

- Overseas markets have ramped up demand for North American recovered paper and plastics, especially in Southeast Asia where China is rapidly building up its paper industry. Many of these buyers are willing to pay prices well over previous market prices in order to meet their current industrial and national demands.

- Traditional price signals no longer work to manage the markets. Municipal recycling programs have turned the once entrepreneurial demand-side market (where shortages led to higher prices, stimulating an increase in collection) to a supply-side market (where materials are collected to keep them out of landfills, not in response to a market demand).

- Municipalities built their recycling programs on the foundation of the earlier successful entrepreneurial recycling system, where brokers collected materials from primarily industrial sources and sold them as feedstocks to manufacturing mills. There was an assumption that municipal programs could just expand on the previous entrepreneurial system, when instead they overwhelmed it, introduced new types of contaminants, and significantly changed it.

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. One newsprint mill calculated that poorly sorted recyclables resulted in an 800 percent yield loss at the pulper, coupled with an eight-fold increase in additional fiber that must be purchased to replace the rejects, at an annual cost approaching $2 million.

With the increased production costs caused by poor quality materials, mills are much less likely to pay more for higher quality bales than in the past and much less likely to get sufficiently higher quality even when they do. In fact, export markets are often paying more than domestic mills can afford to pay, further reducing their access to high quality materials.

Point of Profit

While obviously important, profit margin is not the primary goal for recycling. Communities did not collectively invest billions of dollars, decades of time, and tens of thousands of employees' expertise in order solely to make money for recycling businesses, essential though they are. 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.

If recycling markets are based only on economic goals, the system will be shaped by short-term interests, with little regard to the long-term impacts of those decisions. What happens to the recovered resources then becomes less important than just moving the materials to market.

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.

When, instead, recycling is viewed as a whole system, it is obvious that the quality of the materials shipped to manufacturers is every bit as important as picking up the materials at the curb. Communities must contract for services that include all the elements of the recycling loop.

"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 ascribed to the recycling system while the 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.

COMMON QUESTIONS

Will There Be Enough Markets for Commingled Materials?

Commingled categories of recyclables – mixed fiber, mixed plastics or mixed container glass – are acceptable feedstocks at some manufacturing facilities because of the nature of their production process and the specific products they make. For example, a paper mill making the inner lining for corrugated boxes (medium) or notepad backings can take a wide range of mixed papers. Some plastics facilities making plastic lumber can take a wide mix of plastics. Some fiberglass manufacturers can use crushed mixed glass, even with ceramics that would be contaminants for a glass bottle manufacturer.

But the number of mills within each industry that can use these commingled mixes is quite small next to the much larger number of manufacturers that require separated and high quality materials. Communities that rely primarily on markets that accept commingled materials limit their options, particularly as more programs offer commingled materials to the same markets. High quality and well-sorted materials will always have flexible access to markets, no matter whether they are up or down.

Why Not Simply Send Our Recyclables Overseas?

Asian markets, particularly China, have rapidly developed strong market demand for North American recyclables, especially fiber. Short on the required natural resources and with huge populations that are only now beginning to gain access to many modern products, they have wisely embraced recycling in developing many of their mills. Many recyclers see endless markets for North American recyclables as China begins to supply its billions of people, with India right behind.

But what happens if export demand decreases as other countries build up their own internal markets for recyclables? What happens if there are dock strikes or trade wars? What if energy costs shoot so high that ocean shipping is no longer so cheap as it is now?

What if recyclers by-pass domestic manufacturers needs but then foreign markets take a downturn? Will domestic manufacturers be able to weather the offshore focus long enough to meet returning programs' market needs? Or are many likely to have closed in the meantime, with little or no likelihood of replacement?

What Are Implications of a Global Recycling System?

North American recovered materials have long had strong export markets. What is new is the huge and rapid increase in export demand. Some think that shipping North American recovered materials off to China or other countries is simply expanding the size of the recycling system but not changing it fundamentally. Not surprisingly, the reality is more complex.

When our recycling system was predominantly confined to North America, the materials could be expected to continually circulate, repeatedly being used to make new products, returned to community collection programs, then made into more new products, and on until the materials became too worn for recycling or were incorporated into a durable product or one that cannot be subsequently recycled (such as shingles, plastic lumber, and tissue paper). Glass, of course, can be infinitely recycled.

But the reality changed when the system expanded significantly outside the continent. Many of the exported recovered materials do not re-enter North American markets, such as newsprint, PET and other plastics, changing the ability of some domestic recycled product manufacturers to continue using those grades of materials. Others, such as some corrugated boxes, return as new boxes with new and reduced quality contents that can discourage domestic corrugated recycling. Many trading partners accept commingled materials appropriate for some of their products, such as mixed papers used to make paperboard packaging. But if collected newsprint and office papers go directly into a product that uses mixed paper without having first been recycled as sorted grades, they are lost to the newsprint, tissue and printing & writing mills that also need recovered papers.

If we send such a large percentage of our recyclables to other countries that our domestic recycled content manufacturers can no longer get the quantity and quality of recovered materials they need, they are likely to either close, resulting in more job and revenue losses, or convert to using raw virgin resource materials, resulting in the use of more extraction technologies – exactly the wrong direction for recyclers' and resource conservation interests.

Why Be Concerned With Domestic Recycling Manufacturers?

Some argue for survival of the fittest, no matter where manufacturers are. But again, it is not so simple.

If recovered materials are not available in sufficient quantity and quality to domestic recycling mills, many will close. Losing a manufacturing plant can cost a community far more than simply the direct loss of jobs and tax base. When workers lose their jobs, many other industries such as restaurants, banks, grocers, services, and retail stores, as well as community programs, feel the ripple effects as well. If recycled products become less available as more manufacturers close, local retailers lose some of their product lines and public and commercial purchasers find it much more difficult to find options to close the recycling loop to keep the recycling system going.

Some also question the wisdom of relying entirely on markets and products from overseas, without concern for some domestic self-sufficiency.

What Does the Public Expect?

The public is generally unaware of the dramatic changes occurring in their local recycling programs. They are mostly uninformed about how the materials they collect become new

products. They tend to assume that the materials they set out for recycling are made back into those same products, which is often not the case.

But despite the public's misperceptions about how the recycling cycle works, there are uses that they are less likely to accept. For example, the public is unlikely to enthusiastically save their glass bottles to make roadbeds or landfill filtration systems. They expect their bottles to be made into new bottles.

Similarly, the public is unlikely to enthusiastically support recycling programs that ship all the materials they collect overseas. The City of Montreal found that their public was increasingly uneasy about how many of their recyclables were being exported, providing strong incentive for recycling program officials to search out and even develop markets closer to home.

Why Should We Care If Glass Is Not Returned To Bottle Manufacturing?

If it is reasonable to use recovered PET for cloth fiber, and white ledger paper for tissue, why is it not appropriate to use recovered glass containers for road fill? The difference is in the value of the products to be manufactured from the recovered materials. Using glass containers for road base converts a high value resource into a low value product. Using glass containers for new glass containers maintains their high value. Using glass containers for fiberglass insulation also produces a product with a high value.

Environmental issues are relevant, too. Using recycled glass containers for making new glass containers allows the manufacturer to operate at a lower furnace temperature, reducing air pollution and requiring less fuel. Of course, the recovered glass content can also be recycled infinitely, eliminating the need for equivalent new resource extraction. But the glass recycling life cycle is cut short when it is used for roadbeds or similar uses.

At the same time, the added value must be balanced against transportation costs if there is no local manufacturer who can convert the recyclable materials into a valuable product. However, many communities have found viable glass markets even though shipping their glass long distances.

Why Don't Manufacturers Just Pay More for Higher Quality Materials?

In many cases, manufacturers are paying the same or more than they have in the past yet getting lower quality materials. Quality designations have slipped significantly. At the same time, both their internal costs have shot up and the lower quality materials increase the per ton purchase cost (because of additional materials needed to replace those that were unusable), leaving the manufacturers little room to make higher payments.

Even in cases in which manufacturers are willing to offer higher prices for better quality, many processors prefer to take lower payments for their lower quality materials in order to avoid the extra costs that they would incur to better sort and clean them.

Why Don't Manufacturers Simply Refuse To Take Low Quality Materials?

Paper manufacturers each need hundreds of tons of recovered fibers every day to keep their equipment running and their facilities producing products. If a mill refuses much of the

available material, it risks losing its suppliers to its competitors, many overseas, who are also searching every day for enough material.

The traditional market signals no longer work, now that recyclables are recovered without regard for market demand. But if communities require their processors to produce sufficient quality for any mill, whether domestic or foreign, to be able to use it, then all would have a more level playing field.

Processors Say They Can Sell All Their Materials, So Why Bother With Higher Quality?

Some processors say their quality must be "good enough" because they can always find markets for their materials. But just "good enough" is not really good enough for a long-term recycling economy.

The reason processors are in business is to make recyclables market-ready. Each of the materials markets has specifications for what that means. Processors not meeting those standards currently can find markets with the smaller number of mills that, because of the specific products they make or the production systems they have, can take commingled materials, or with overseas mills that have low enough labor costs that they can afford to re-process the materials all over again. But that does not mean that the processor is doing a good enough job.

Processors play a critical role in the recycling cycle. If they send fiber bales with glass and containers to paper mills, they have failed to support the long-term health of the recycling economy. Many paper mills, both domestic and overseas, are adding processing equipment to their facilities in order to offer some protection to their manufacturing equipment, which usually is valued in the hundreds of millions of dollars. But this represents a failure by the processing sector. Community program managers should require their processors to avoid, or correct, this situation.

In addition, as more municipal governments switch to single stream programs, they will add to the competition for the smaller number of manufacturers that can use poorly sorted materials. Smart governments will instead ensure and protect their markets by producing high quality materials that can be used by any appropriate manufacturer.

Why Not Just Rely On the Free Market?

Recycling is not simply about buying and selling materials. Those are the means for keeping the system functioning, but they are not its goals. Recycling, instead, is focused on environmental goals for conserving natural resources, water and energy – values that the marketplace does not adequately take into account.

In addition, many of the costs of a poorly run recycling system do not fall on those buying and selling. A processor is not concerned with whether domestic recycled product manufacturers stay in business, but communities and governments pay a high price, including monetary, non-monetary and environmental, when a manufacturer closes its facility or abandons using recycled content. Governments must represent these public interests because sheer economic forces are not comprehensive enough to do so.

Isn't the Goal To Divert Recyclables From Landfills?

The original concept of "diversion" assumed that if recyclables were not being landfilled, they must be being recycled in a manufacturing system. There was no contemplation that the materials might be diverted but then not be usable by manufacturers. In fact, many recyclables are diverted from the local jurisdictions where they are collected, but still end up landfilled near manufacturing sites.

This is not the intention of diversion, but it is the result of using diversion as a goal in itself rather than, more appropriately, as a means to achieving recycling. Diversion is not an adequate driver for a healthy recycling system because it does not distinguish between recovered materials that actually do get recycled and those that do not. The concept of "diversion" needs to be expanded to include the ultimate fate of the recovered materials.

As Long As Materials Get Recycled, Isn't That Enough?

Recyclables can often be used for making several different kinds of products, including:

- Products that require well-sorted materials and can continue to be recycled many times, such as newsprint, printing and writing paper, glass and plastic bottles, and metal cans. These high quality, well-sorted materials usually have the greatest versatility within their industry's markets, as well.

- Products that require well-sorted, high quality materials but are impossible or unlikely to be recycled, such as glass used to make fiberglass.

- Products that can use commingled materials and that can be recycled, but only into similar products. For example, paperboard boxes and corrugated medium (the fluted layer in the middle of corrugated boxes) both can use commingled fibers and both can be recycled. But once the commingled fibers have been used in these products, they cannot be sorted back into grades suitable, for example, for making office paper or newsprint grades. While office papers and newsprint can be "down-cycled" to make paperboard and medium, the resulting products cannot "up-cycle" into grades that require sorted fibers, thereby reducing the capacity for incorporating recycled content into products such as newsprint and printing and writing grades.

- Products that can use commingled materials and are durable and/or unlikely or impossible to recycle. Plastics can be commingled to make plastic lumber, paper can be commingled to make shingles and notepad backings, glass can be crushed unsorted for roadbeds or landfill daily cover. While these can be good uses for some of the materials, when they are the first destination for recyclables, all the other potential subsequent recycling uses are eliminated.

- Products that are made to be used only once. The most environmentally responsible choice for many tissue products, for example, is recycled content, even though their purpose precludes their reuse. Other one-time-use products may not play such a necessary role, and yet take recyclable materials out of the markets permanently.

If a recycling program's only goal is diversion, then any of these different uses for recyclable materials is equivalent to all the others. But if diversion goals are combined with requirements for maximizing recycling benefits, then it becomes clear that using mixed paper to make shingles moves only one step away from the landfill, while sorting the paper so it can be used

for printing and writing papers generates up to a dozen times the environmental savings because sorted office papers can be recycled so many times into new office papers.

Municipal governments have not poured billions of dollars and enormous resources into creating and maintaining their recycling programs just to get one step away from the landfill. Yet when their programs produce such poorly processed material that the only markets they can be sold to are for products that cannot be repeatedly recycled, they eliminate the exponential environmental savings they could have generated if they had required higher quality processed materials.

Part of the answer to ensuring enough volume of recovered materials is sorting them well enough that they can be used over and over for new recycled product manufacturing.

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,
- Emphasize recycling markets that allow recyclables to be used repeatedly whenever possible,
- Require that the collected materials not be used for landfill alternative daily cover (ADC) or other non-feedstock purposes,
- Contract for recycling services that include all parts of the cycle, not just collection. Just as recycling contracts typically specify collection service requirements, they should also specify processing and marketing requirements to meet the specifications for the industries that will use the recovered resources in the manufacture of new products. It is in recyclers’ best interests to support the quality that will encourage further development of recycled product

manufacturing opportunities, particularly in areas without local options for particular materials.

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 more to designing a recycling program than contracting for collection of materials that are sent to a MRF. It is the community's responsibility to provide the goals and direction for the entire recycling program.

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. 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 are its recycling goals?
- 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 ARE THE COMMUNITY'S RECYCLING GOALS?

At a minimum, the community should collect only recyclable materials for which there are available markets, and process the recyclables to the specifications requested by the buyers of the materials. To the maximum extent feasible, the community should look to return the collected materials to manufacturers who will make products that are continuously recycled and reduce the need for extraction of raw materials.

While local governments are charged with providing cost effective services, that does not mean that they are not charged with providing the lowest possible cost services. When collection

companies submit bids for recycling services, communities are not requesting that they buy the cheapest possible trucks, or the least expensive processing equipment available, but rather that they make the appropriate capital investments. Collectors buy trucks that will not break down on the route. Processors should be expected to buy the right types and size of equipment to process the recovered materials.

It is important for local governments to identify the services that they wish to have provided and seek competitive bids for these services, rather than simply accept what a contractor says it is willing to provide. Communities should pay the processor to produce the quality materials that meet the manufacturing industry specifications, and not market recyclables of barely acceptable quality.

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, available markets, and the public's expectations and level of participations. 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.

Materials that can easily be collected and processed include:

- Dry, clean fiber, such as:
  - old corrugated containers (OCC)
  - old newspapers (ONP)
  - mixed paper (MP)
  - office paper (OP)
  - white ledger (WL)

- Aluminum and steel/tin cans
- Glass and plastic bottles and jars

Materials that are generally not collected include:

- Soiled and food-contaminated paper (except sometimes in composting operations)
- Any metal items bigger than a large tin can
- Any glass that is not a bottle or jar (e.g. Pyrex™ and other glass cookware, plate glass, drinking glasses and mirrors, which are serious contaminants for glass beverage container furnaces)
- Ceramics
- Rocks and stones
- Mixed material items (such as toys)
- Garbage

A wide range of materials do not fall into either of the above two categories. Many of these items (such as scrap metal, film plastics, textiles, and dry cell batteries) can be recycled if the processing system is designed to handle them and if there are markets available to the local community. Additionally, items such as electronics, paint, and hazardous wastes may be recovered if processing technology and markets are available, but they are not generally compatible with a single stream recycling program.

In addition to the typical dry recyclables listed above, various organics – including plant trimmings, food wastes, and food-soiled paper – can be separately collected and composted.

Currently there are several problematic types of materials that program designs should either avoid or have specific plans to ensure they can be adequately processed, including:

- 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.

- Non-container glass, ceramics, rocks and stones are all serious contaminants for glass bottle manufacturers. If residents are well-educated about the problems these specific materials can cause, most will not set out such contaminants for collection.

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

For all the materials to be collected, but especially for any on the “not generally collected” list, it is essential to identify what percentage will actually be recycled, and how much of that material type will likely end up being landfilled because it is contaminated, the processing facility was not properly designed to handle it, or does not have sufficient value to be recycled.

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.

Which recyclable materials are collected will also affect the collection cost. The most valuable and highest density materials are aluminum, tin cans, glass bottles, and newspapers. In order to recover a larger percentage of the waste stream, programs may need to add materials with less value and lower density, but this can reduce the cost-effectiveness of the recovery programs.

Additional materials may also mean that collection truck drivers must collect more than one load each day, so the driver spends more time going back to unload and return to the route to finish collection. If drivers are already collecting two loads, then the collection time is less affected, but it may cost more to process lower value materials than the additional revenue generated.

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.

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. For example, Steven R. Stein, in the October 2004 *Resource Recycling* article titled "Single-stream: a recycling method that cuts both ways," cites two examples of communities in Montgomery Co, MD that almost doubled volume, and a third that increased by about 60%.

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 green waste collection). The addition of new materials categories increases volume of all collected materials.

- Affluence or an improving economy. San Diego's single stream program doubled its recovered materials but its volume of garbage did not decrease appreciably. Its program happened to be introduced just as the area's economy was improving, so residents over time had more materials to dispose of.

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. San Jose, CA, for example, found that its PAYT program encouraged residents to put extra garbage in the recycling carts in order to avoid higher garbage fees. 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 key to a successful single stream recycling program and communication with the public is an essential element for this success. Recycling programs give community residents the opportunity to contribute to conserving resources and improve overall environmental quality, and most are eager to participate. Not only is good communication necessary when first introducing and rolling out the single stream program, it remains as important 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. While it may seem simple to tell residents to mix all their recyclables together, single stream actually makes it even more critical that they understand exactly what to put in the carts and, just as importantly, what not to.

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. Collecting only the right materials, which have been properly prepared, helps the processor do the best job possible.

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. In most cases, the collector's strength is collection, not promotion. At the same time, the collector is often the residents' most direct connection to the recycling 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 may contract for it.

Educational materials should be delivered to residents with their recycling containers, in customer bills, through newsletters, and in response to phone calls and questions.

Communities can require the collection contractor to contribute to the cost of the promotions program and include that cost in the rates charged to the residents.

INITIAL COMMUNITY COMMUNICATION

Community participation can be helpful early in the program design process. Several program managers now say they wish they had conducted neighborhood focus groups or otherwise gotten local input on program design and details in order to ensure smoother acceptance. Community feedback in the program design phase can 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, including being able to choose sizes matched to individual household needs and choosing sizes over the whole range of service carts (e.g. recycling, garbage, greenwaste, foodwaste) simultaneously to ensure compatibility.

Once cart colors are chosen, they should remain consistent throughout the program so that promotional materials can be keyed to the colors. For most program participants, the cart itself is the most visible manifestation of the program. A consistent color, acceptable to the community, identifies and publicizes the recycling program, makes it easier for residents to associate the right materials to be collected in each color cart, and encourages participation, especially when they see the recycling-color cart placed out at curbs all down the street and throughout a neighborhood.

In early curbside collection programs, recycling bins were generally brightly colored to make them stand out to the residents and to call attention to recycling opportunities. But now, as programs have matured, most residents prefer a cart that more easily blends into its surroundings.

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. It is easiest to get residents' attention when the program is new, or when it is expanded or upgraded. In fact, some long-established programs make minor changes so that they can announce that the program has been improved, in order to renew their residents' attention to recycling.

Residents need to clearly understand what materials the program collects and how to prepare them. Most 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 in ways that will encourage residents' accuracy. Knowing the correct materials that are acceptable for recycling programs is not intuitive; the public does not categorize products and materials in the ways that recycling professionals have learned to do. Therefore, to communicate the program's needs effectively, use the right language, including terms that match those the public uses in everyday communication.

If you ask your residents for "glass," residents may throw in drinking glasses, plate glass, ceramics and mirrors along with 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. This will also help clarify that other products such as aluminum foil, aluminum plates, and plastic food trays are not acceptable. In fact, Oakland, CA does not mention material types at all, but uses graphic sketches to focus residents on collecting only the shapes that happen to result in the specific forms of materials appropriate to their program.

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 boxes. If your program takes magazines and catalogs, make that clear to residents, who otherwise may be likely to throw them away.

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.

Many recycling programs have found that they 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 bottom of the bottle. Accepting all plastics puts an additional burden on your processing facility, but if it has been designed to separate the plastics you can market from the others, the amount of plastics recovered 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. The approach that appeals to residents in one community may not be successful or even meaningful in another. Even within one community there may be a wide range of cultural or demographic features, and each may require a different promotional plan. While it is important to vary the messages to appeal to different groups, they should still maintain a consistent theme so that they are easily recognizable as part of the same recycling program.

Most programs find that picture-based communications that emphasize graphics and minimize text are most successful. With today's emphasis on television sound-bites, the simpler the message, the more likely it is that residents will understand and implement it correctly.

Well-planned graphics-based communications are also most versatile in a multi-cultural community. In fact, several surveys have found that residents who speak English as a second language prefer materials in English over those that are translated from English into a form or dialect they do not use. In addition, many new recycling concepts do not have equivalent terms in other languages.

Clearly, then, the simpler the message, the easier it is to get the desired result. With so many different types of communications competing for people's attention, you only get to say a few words before the listener is ready to move on. Those first few words are critical to getting their 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

Printed materials that promote the program to the community and educate residents may include flyers and posters that show the types of materials to be collected, introduce mascots that encourage participation, and celebrate program successes. They may be bill inserts that remind residents to participate, coloring books and materials for school children, or quarterly newsletters announcing special collections and reminding residents again of the proper materials to collect and how to prepare them. They may be delivered directly to residents or displayed in public places.

Whatever the form and venue, when printing materials you need to balance how much material to put into a single document with how to create a piece that attracts readers and gets 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 not all audiences are likely to follow up for more information. The details that are most important for them to know need to be in the printed piece in their hand.

Printed materials should stress the need for quality, so that the recovered materials can be made into new products. And, of course, make sure educational materials model closing the loop: printed pieces should always be on paper with recycled content. (Find potential brands and sources at http://www.conservatree.org.)

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

  The media is more likely to cover stories about a program that is new or expanded or that includes new information (such as tonnages recovered last month or in the past year, and notable successes). Electronic media is more likely to cover stories with moving equipment than stories with "talking heads."

- **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 brochures, instruction cards that can be attached by magnet or adhesive backing to household appliances or cupboards

- **Internet** – Recycling program website

- **Newsletters** – Programs often produce quarterly newsletters to send to residents. The most effective newsletters tend to be highly graphic and use colors and designs consistent with the program's promotional materials. Some use mascots or historical tie-ins, Q&A columns, activities for kids, and advisory groups made up of residents who provide feedback and comments on the newsletter and program. Include a phone number and e-mail address so that newsletter recipients can get questions answered and provide feedback.

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

Use different types of approaches to appeal to a wide range of audiences and incentives for recycling. Motivations for change cover a broad spectrum. Some people are convinced by statistics and information about the impacts their efforts can have on the environment or their community. Others are more influenced by a word from community leaders such as the mayor and city council. Still others are best convinced when they learn their neighbors and family see value in the program. A number of programs have integrated the use of community-based social marketing to identify specific obstacles to their residents' participation and strategize how best to overcome them.

Recycling programs may also want to share negatives with their residents, especially if that can lead to correcting a problem. For example, a program that collects plastic bags might want to highlight the number of dirty plastic bags that ended up in the landfill, unable to be recycled, and then explain that simply putting many bags into one bag before setting them out for collection will solve this problem and produce a recyclable, marketable product.

MEASURING PROMOTIONAL EFFECTIVENESS

Measuring message effectiveness can be used not only to evaluate the success you have had, but also to illuminate refinements needed to improve the program. Determining the actual impact of messages can be difficult because there are so many factors in play and the results may be cumulative rather than immediate. But still there are a number of different ways that messages can be measured, including:

- 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? (Studies have long shown that people usually need to be exposed to messages multiple times before they actually absorb them.)

- How many tons of recovered materials were set out for collection after the message was delivered as compared with before the message?

- Is there a change in the contamination rate after information is distributed to the residents, 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

Not only do residents need to know what to collect and how to prepare the materials, they also need to know how well they are doing. Feedback can tell them when their participation needs improvement and how to do it. It can also applaud them for doing it right. While these two approaches can be combined, they are generally independent of each other.

Residents who are doing a poor job of recycling need to be identified and educated. In a single stream program, this is particularly important because a proliferation of contaminants mixed into the recyclables may undermine the ability of the MRF to process high quality materials, particularly when it relies heavily on equipment to sort materials. In a best practices system, the incoming materials need to be particularly closely calibrated to the facility's sorting ability.

Types of feedback loops:

Identification and Correction of Problems – In most communities, if a resident overloads their garbage can, the collector leaves a "Non-Collection Notice" explaining why the garbage was not collected, such as "Your garbage can was too heavy." Collectors of recyclables tend to be more reluctant to deliver negative feedback because they worry it will discourage recycling, but it is an essential step in providing high quality materials to the processor.

Chapter 6, *Collection System Design*, discusses the responsibility of collection drivers to identify and tag or log inappropriate set-outs. Depending on the system used, the collection company may follow up with these residents or the promotions program may take on that task. Options include:

- Drivers tag the contaminated set-outs with a notice such as, "We took your recyclables, but please note for the future . . . ." The notice (which may have check-off options) should explain precisely why the set-out materials do not meet the goals of the recycling program and how the materials can be properly prepared the next time, while encouraging the resident to continue to participate.

  Tags should be designed to tie in visually with other promotions and educational

materials the residents will see about their recycling program. Attractive graphics are likely to be more positively received than a tag that looks like a parking ticket.

- Drivers tag the contaminated set-outs with an explanation for why the materials were not picked up.

- Drivers log the contaminated set-outs so that a route supervisor can contact the household and request that they properly prepare their recyclables.

- Collection company sends a notice to the household or even makes a visit to explain the correction needed.

- Route supervisors or recycling teams walk specific streets on collection day, before the recycling truck arrives, to check the quality of set-outs and leave notices for those that need correcting.

  For example, a supervisor could leave one of three tags: 1) A red tag that tells the driver not to collect the materials and tells the resident that the recyclables were too contaminated to collect; 2) A yellow tag that tells the resident the recyclables were collected but in the future please make the following changes; or 3) A green tag that thanks the resident for good recycling participation.

- If a household consistently provides contaminated materials even after several contacts explaining the problems and how to correct them, then they should be asked not to participate in the recycling program. Continued non-compliance results in the collector removing the recycling cart. One California community (Modesto) even charges the residents garbage service rates to collect contaminated recyclables as garbage.

General News About Program Successes – Electronic media, newsletters, and bill inserts are good ways to let the general public know what they are doing right. Applauding their efforts can encourage more to participate.

Rewards for Good Quality – Rewards programs can encourage residents to take more care with quality as well as encourage more to participate. Some examples of innovative reward programs, based on varying budgets, include:

- Chula Vista, CA sends out teams of “Recycling Rangers” to check the contents of recycling carts and leave either orange tags (advising the resident how to improve the quality) or white tags (thanking them for making their town a better place to live).

- Woodbury, MN awards $50 to lucky residents who “Get Caught Recycling” if their recyclables are on the curbside on collection days. Winners’ addresses are randomly chosen through a computer sort.

- Berkeley, California tried a “Cash for Trash” reward program in which the contract trash collector got permission from residents at randomly selected addresses to search their trash for recyclables. Those with no recyclable materials in their trash were awarded cash prizes of $250 or more. If no winners were identified, the prize money rolled over to the next day for a potentially larger reward for the next winner.

- Philadelphia’s residents are enthusiastic about their RecycleBank reward program, which records “RecycleBank Dollars” in their personal online accounts that can be spent at participating local stores. The amount of RecycleBank Dollars is calculated based on the

weight of recyclables in each household's recycling cart, matched to a barcode on the cart that is scanned as it is emptied into the collection truck.

CLOSING THE LOOP

The public – indeed, even many recycling professionals –think that collection is "recycling" because it is the most visible part of the system to them. When someone says they recycle, they are usually talking about the bottles, cans and newspapers they put out for collection.

Part of the public education program should include the message that recycling is not complete until the materials that are collected are made back into new products by a manufacturer. Communities should encourage the public and local businesses to help their community recycling program close the loop by making sure the products they buy include recycled materials content.

The public generally is not aware of what happens to their collected materials or how they are made into new products. While most recycling programs tend to feel that educational focus should be kept on how to participate in their local program, many also add basic information about how recycling transforms old products into new ones. Resident who want more detailed information can then contact the recycling program for leads.

ONGOING PROMOTION AND EDUCATION

While promotional materials make a big splash at the program roll-out, it is important to continue to promote the program throughout the life of the program. People need regular reminding about the recycling program and continually refreshed information. New residents come into the community and need all the introductory information to learn how to participate.

Newsletters, media stories, and recycling program participation at community events maintain recycling as a "current" activity.

The promotions budget should be large enough to 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. 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

When you talk with the public about what recycling means to them, you most often hear:
"I save my bottles and cans for recycling!"
"I put my newspapers out to be collected from my curb!"

Collection is the part of the recycling cycle that is most visible to the public, as well as 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 into one compartment on a truck. Since single stream recycling was initiated by the collection industry to increase the efficiency of their operations, commingled collection has come to symbolize the system.

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 agree on what is expected of each of them. Their cooperation is key to optimizing the collection of recyclables. This includes determining:

- What is the impact of the recycling collection program design on the garbage collection system?
- What is its impact on other collection system elements, such as collection of plant trimmings or compostables?
- What is the impact of each of these collection program elements on the processing system for the recovered materials?

Local governments should specify as completely as possible the standards they want from their collection companies and route drivers. (See *Appendix: Contracting* for details.) If the government manages its own collection, its standards should be spelled out for all managers and drivers.

COLLECTION VEHICLES

An almost infinite number of variables of collection vehicle design features are available. Should recyclables and garbage be collected in a single truck with two compartments, or should the collector use a dedicated truck for each one? How often will each category be picked up from residences? How will green waste and other collections be integrated into the vehicles and schedules, if they are offered to the community?

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 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. Making an extra trip to unload adds considerable time onto the work day, the driver may be reluctant to do this and, instead, may mix the materials – dumping garbage into the recyclables, or recyclables into the garbage – in order to avoid making an extra trip.
- 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 during 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 of single stream collection is the opportunity to automate the process. In fact, many argue that most of the benefits claimed for single stream systems actually result more from 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 that are large enough for meaningful 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.

Pay-As-You-Throw (PAYT)

PAYT systems are designed to reduce the amount of garbage that people dispose of because they have to pay for waste by the increment they generate, rather than pay a fixed amount per month with no disposal limit. This is one way to encourage residents to pay more attention to what they purchase and to encourage recycling behavior.

However, at this time there is no clear evaluation of the impact of pay-as-you-throw on the quality of materials recovered by single stream recycling programs. The uncertainty results from the number of variables that are involved in material quality, and the variety of the details of single stream programs around the country – such as the number and types of materials collected, promotional activities, enforcement of the rules, types of collection vehicles, and the abilities of the processors to manage different types of contaminants.

Some anecdotal evidence suggests contamination increases when residents opt for less garbage service to lower their rates. Some then place their extra garbage in with their recyclables where there is more room than in their garbage cart. PAYT is one part of the reason that San Jose, CA has a high contamination rate, while San Diego, which does not have PAYT, has a low contamination rate.

Cart Selection

Single stream collection only requires one recycling container. It should be large enough to hold all of the materials that a resident might generate between collection intervals.

Selecting the appropriate container size for a particular neighborhood requires balancing efficiency with space considerations. The larger the container, the more material it will hold and the fewer the number of times the resident needs to set the container out for collection. The collection system is more efficient when the driver can stop fewer times to collect the same amount of material.

But the larger size containers also take up more space at the residence. Many residents complain that 96-gallon carts are too large to fit into their garages or through their side yard gates. The 64-gallon carts are easier to maneuver but only hold two-thirds as much material, so must be set out more often. The loading height of a 96-gallon cart is also higher than for a 64-gallon cart, so if small children in a family are tasked with taking out the recyclables, they may have trouble opening the container lid and getting the recyclables into the cart.

Large carts also can be problematic in densely populated areas where homes may not have front or side yards, in multi-family dwellings where residents may need to take bins to their own residences, or in areas where streets may have unreliable curb areas for part of the year because of heavy snow.

CONTAMINATION ISSUES

Automation can also affect contamination levels in the recyclables. In a manual or semi-automated collection system, the driver has an opportunity to look at the materials before they are loaded into the truck. In order to prevent contaminating all the other materials already in the truck, the collection contracts for these types of programs should require that the driver refrain from collecting contaminated materials. Instead, they should leave a "non-collection notice" with the materials that were not collected, explaining why.

In a fully-automated collection system, however, the driver cannot see what is in the load until it is already dumped into the truck. Collection contracts for this type of program should require the collection company to mount a mirror or camera above the hopper, or install a closed circuit camera above the hopper and a monitor in the cab. The driver should be required to observe the materials as they are dumped and either leave a "notice of incorrect set-out" attached to the cart when a contaminated load is spotted, or log the infraction on a reporting sheet in the truck for a route supervisor to follow-up with the resident.

Alternately, the route supervisor can stop before the collector arrives at locations where recyclables are regularly contaminated and tag the problem 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.

No matter what the collection system, the collector should be required to identify repeat offenders so that route supervisors can check the bins or carts at any locations that have been tagged more than once in the prior three months. Identification might include a route log of the location of problem materials, or a copy of the notice attached to a cart.

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.

DRIVER RESPONSIBILITIES

The collection vehicle driver plays an essential role in keeping the load of collected materials contaminant-free. Collection program design usually focuses on the contractor or, if the municipal government does its own collection, the design of routes and choice of carts. Often overlooked, but actually critical to the success of the contract and collection, is driver training and incentives.

For collection programs to get the best results from drivers, they must make performance an important condition of continued employment. Therefore, from the very start of the program, the company must identify those activities that are most important and then build them into worker training.

When a new contract begins, or when new employees are hired, the program operators should provide all employees with details about the expectations relating to keeping the recovered recyclables free of garbage and other contaminants, and maximizing recovery of recyclables. This means checking each load before or as it is loaded into the truck and communicate with

residents who do not properly prepare their recyclables. The program operators should stress the need to deliver clean materials to the processing facility so that high quality materials can be shipped to market. It may help to provide the drivers with information about how the recovered materials will be used so that they better understand the problems that they can create by not managing their collections properly.

Part of the training should include how the collection route should be managed and the need to avoid overloading the vehicle. In most communities, the recycling drivers collect more than one load per day to complete their route. To minimize the damage done to the recyclables by compaction, the operators should stress that the drivers should bring in the first load when they are about 60 percent of the way through their route. This point should be indicated on their route information (or route map), not be left up to the drivers to decide when to come in to the processing facility. This technique can also be used to spread the time when the drivers arrive at the processing facility, so trucks do not backup while waiting to unload.

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 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, and
- 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.

Processor. The community should ensure that there is feedback from the processor to the collector regarding the quality of the materials received. This may take the form of the processor inspecting loads at the MRF as they are unloaded. If there are on-going problems, the management of the collection program should station a supervisor at the processing facility to examine loads and talk to the collectors about the quality of the materials that come out of their trucks. It may even be appropriate for the processor to take samples of some loads, sorting and weighing the component parts to determine the actual contamination. This sampling could be paid for by the community, the collector or the processor, depending on who had what responsibilities under the contract(s).

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

- Non-targeted materials that technically could be recycled, but are not part of the current collection program. These may cause problems for the processor whose facility may not be designed to remove them.

- Materials that cannot be recycled and should not have been collected, such as garbage.
- Materials that are on the list of recyclables, but are contaminated during collection. For example, promotional materials for a single stream program should stress that liquids left in food and beverage containers could degrade the quality of the recovered paper.

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.

COMMERCIAL COLLECTIONS

In some communities, commercial recyclables are collected in the same truck as residential recyclable materials, even though the types of materials may be very different. For example, offices will have more white paper and less newspaper than a residence. If the white paper is not separated from the residential mixed paper, this high value material may be lost to the white paper market, decreasing the ability of paper manufacturers to provide recycled content in printing and office papers, and tissue products.

If cardboard (OCC) from retail stores is collected and mixed with the paper from a residential single stream program, it may be more difficult for the processor to separate the boxes from other paper.

A collection truck that stops at restaurants and bars along its route will pick up heavy loads of glass bottles that can be most efficiently processed if they are not mixed in with residential loads.

In addition to the problems created by co-collection of residential and commercial materials, the combining of separately collected materials at the MRF may cause similar separation problems.

Commercial recycling programs usually concentrate specific types of materials from specific types of businesses. In order to produce quality materials at the MRF that are appropriate for use in products that can be repeatedly recycled, the commercial and residential recyclables

should be collected separately, with commercial streams such as glass or white paper kept clean and not commingled, or these streams should be processed to a high degree at the MRF to separate them back into their highest quality.

Once concentrated materials streams such as all glass or specific grades of paper arrive at the MRF, they should be maintained separately and not mixed before processing. Some processing facilities have the ability to introduce separate streams part way along the processing line so that the already sorted materials do not have to be run through the entire process.

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

The processing system's design and operation are critical to the quality of materials shipped to manufacturers of new products. Currently, processing is most often the weak link in single stream recycling systems and the source of many of the poor quality feedstocks arriving at manufacturing mills.

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.

Critical Components

Each processing facility design must be matched to the characteristics of the local recycling program(s) it will serve, including what materials will be processed, how much volume is expected, what condition they arrive in, what markets are available for the sorted materials, those markets' requirements, the contract requirements of the communities using the MRF, and the price that will be paid for the sorted materials. We will discuss many different variations and impacts below.

Yet no matter what the variables, there are some standards every single stream MRF needs to meet in order to perform to a Best Practices level. It 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

Initial Questions

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.

Often communities assume they have no choice but to accept whatever processing capabilities a franchised collector may already own or arrange to use. But communities always have the right, and indeed the responsibility, to require that processing meet their program and policy goals. Chapter 8, Contracting, discusses ways to leverage processing specifications through contracts.

Whether the single stream program will use a new MRF or an existing processor, there are a number of questions that must be addressed in order to evaluate how best to handle the program's recovered materials. These questions can help a municipality decide whether a specific MRF is appropriate for handling their single stream material, or if they should modify the list of materials to be collected. They can also help the processor decide whether it will be able to produce high quality manufacturing feedstock materials from the recyclables the municipality collects. Both the processor and the municipality may be able to collaborate on adjustments to the recycling program design and/or the MRFs system in order to improve processing capabilities.

- ***What materials are in the loads that will be delivered from the collection program?*** A MRF designed for a specific range of materials may not be able to add new ones without compromising the quality of the commodities it produces. 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 type?*** 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, the MRF design must take into account changes in behavior of the participants. 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 with the containers, and then are disposed with the 'fines' that are not sorted. But this fiber can be separated and recovered if it is part of the facility design.

- ***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?*** High compaction rates 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. Does the condition of the paper vary by season? A covered truck will keep out rain and snow. It is easier to process dry paper; wet paper is heavy, prone to mold, and difficult to sort. 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 its 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, more of the glass bottles are broken, more glass fragments are embedded in the paper fiber, and the recyclable materials degrade.

- ***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 protected space for types of materials that are far 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.

  If the MRF has markets for white ledger or office papers, it will need to keep the paper dry, and equipment and workers trained to properly separate the papers. Paper mills that want the specific grades of paper that the MRF sorts may be nearby or a thousand miles away. There may be a local paper mill that makes products for which commingled papers are an acceptable feedstock. Because it is so heavy, glass is generally not shipped very far, although some communities have successful glass markets several hundred miles away. Plastics are easily shipped internationally and there are recycling plants that will sort mixed plastics into marketable high grades if a MRF does not have the capability.

- ***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 market relationships 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.

  For example, in the Portland Metro area residents were asked to keep the glass separate from other recyclables in its otherwise-single stream collection system. They were asked to place the glass out in their old recycling bins so collectors could pick up the glass in one stream and all other recyclables in a second stream. But keeping the glass separate does not work for many residents and some of the collectors do not take the time to remove the glass that they find in the single stream recycling containers. As much as one-third of the glass received at the processing facilities arrives mixed with the other recyclables. The MRFs were not originally set up to handle glass commingled with other materials, and have had to go through difficult transitions to accommodate the lack of proper separation by the residents and collectors.

Over time, program managers recognized that, despite extensive public education and program promotion, residents would not meet that assumption reliably enough to avoid significantly changing the characteristics of the materials delivered to the MRFs. Therefore, the processing design could not succeed so long as it relied on the public's meeting the ideal and had to be adapted to provide more flexibility.

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 total amount of recyclables that are received. The material in the truck should be sampled at this point 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 general storage 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. Because of the size of the bucket on the loader, the volume of materials arriving at the processing line tends to be inconsistent, with large surges followed by blank space. New load leveling devices have recently been developed.

6) Most designs remove large items first, such as corrugated boxes, so that smaller items can be exposed for later sorting. In some 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) Modern screens may have two or three stages that separate multiple material types, so that the recyclables that pass through the cardboard screen will be further separated into large sheets of paper (e.g. newsprint) and other materials (e.g., beverage containers).

The third screen may separate the rest of the paper (e.g. high grade sheets and bulk mail) and film plastic bags from containers.

9) 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.

10) Small item fractions on the conveyor belt are screened to remove the fines (tiny fragments of materials). They may become part of the facility residue or 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.

11) 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. The residue is then delivered to a landfill.

12) Sorted recyclable materials are baled for transport to manufacturers or to other facilities for further processing. Some are loaded loose into trucks (e.g. glass and sometimes newsprint), depending on specific market requirements.

Each of these steps deserves further, fuller discussion.

RECEIVING MATERIALS

Generally, materials are not processed as they arrive at the facility and are unloaded from the truck. Most often, they are dumped directly onto a concrete tipping floor, then loaders push them up into a big storage pile to provide adequate space for other loads to be added. The way that this step is handled can improve or reduce the recovery rate and the quality of the processed materials.

First, it is important to note how far the material falls and onto what kind of surface. The glass bottles (and certain contaminants) are generally the only breakable items received. Minimizing or cushioning the drop at the MRF can help maintain glass quality.

Next, as the pile of delivered recyclables grows higher and more materials are pushed into it, cylindrical items such as cans and bottles are more likely to roll back down and be crushed under the loader's wheels. The more the loader crushes the glass, the more likely it is to be ground so small that it will end up in the paper shipped to market, or in the facility residue being sent to a landfill. Loaders that drive back and forth over the materials in a pit can produce the same effect.

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 virtually guarantees that most of the glass bottles will not be usable in the manufacture of new containers. There are glass furnaces in many parts of the country that need recovered glass to optimize their production process. Many of these furnaces need color-sorted glass and this is far easier to achieve with whole or large portions of bottles

than with tiny shards and slivers. Best practices require developing a system that keeps the glass out of the paper and plastic while also maximizing recyclability of the glass.

Glass is the primary breakable material at the MRF. 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 itself 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 glass is separated from other material types and the contaminants are removed from the glass containers. 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.

Appendix 2 describes a proposed low-impact processing system to separate glass from other recyclables while maintaining its recyclability, as well.

TYPES OF PROCESSING METHODS

MRFs use a combination of workers and equipment to sort recyclables into recovered materials categories. Large processing facilities primarily use mechanical and optical sorting instead of manual sorting to increase throughput and efficiency, and to produce a more consistent marketable commodity from the materials received.

There are many different types and configurations of processing equipment, with new ones being developed or introduced from other countries at a rapid rate. This Guide is not intended to promote one type over another. Rather, it describes the use of many of the variations available, and the role that each plays in an overall processing system.

EQUIPMENT

Mechanical sorting equipment uses many different approaches to separating commodities by size, weight, and shape, including:

- **Conveyance** – Recyclable materials are carried through the processing center on moving conveyor belts and many different types and sizes of screens. One element of the low-impact sorting system is an inclined belt at a steep angle, with short cleats moving at a fast speed so it can move paper and other flat items upward while three-dimensional items bounce and roll off and/or fall through holes in the screens.

- **Openings (holes and spaces)** – Screens with holes, or sets of disks with openings, that allow smaller materials such as bottles and cans to fall through, but not larger, flatter materials such as paper sheets, can quickly separate materials into two streams. Cylindrical screens, called trommels, sift materials inside a cylinder that turns continuously, somewhat like a cement mixer, so that larger items come out the far end of the cylinder, while small items fall through the openings in the screens.

- **Shapes** – Different sizes, shapes and configurations of discs can lift and roll larger, flat items along the screen while smaller items fall through.

- **Vibration** – Shaking can separate denser materials into a different path from lighter materials or small items from larger ones. Pulsating screens can be a very effective way to separate some materials.

- **Reverse Direction** – Materials that are dropped off one conveyor belt onto another belt below that is moving in the opposite direction can be used to flip paper over as it waterfalls to the second belt. This action allows the glass that may have been trapped within the paper on the first belt to be removed by subsequent screens.

- **Magnets** – Ferrous materials (e.g. steel cans) are quickly separated from non-ferrous metals (e.g., aluminum, copper and brass) and other materials (e.g., plastic and glass containers) by a large magnet. Alternating magnet directions (referred to as an eddy current separator) can create a force field that will separate non-ferrous metals such as aluminum cans from non-metallic similar shapes such as plastic bottles.

- **Blowers** – Air blowing through a falling stream of materials will move lighter items farther than denser ones, sorting them by type. Blowers can separate paper labels from glass, spread paper out on a conveyor belt, or push paper up a conveyor ramp while heavier items fall through screens beneath it.

- **Partitions** – Strategically placed dividers can separate materials into streams following different pathways.

- **Vacuum** – Lighter materials such as plastic bags can be lifted off a sort line by a vacuum, leaving the heavier materials such as paper and beverage containers behind.

- **Densifiers** – Compactors, crushers and balers densify materials for shipment to end markets, more processing, or landfills.

Processing equipment can be designed to sort any mix of materials. Of course, certain types of materials create problems for certain types of equipment, but alternatives can correct these problems. For example, discs and star screens are not designed to process long “stringy” items

(such as textiles, power cords or film plastic), but some find that finger screens (vibrating bars that let small items fall through) can do the job. The problem can be avoided entirely by either not collecting these types of materials at all or designing the processing system to ensure that they are removed prior to reaching disc and star screens screens.

Optical sorting equipment is playing an increasingly important role in sorting recyclables. By measuring light waves, transparency or color, optical scanners can sort paper into different grades, plastics from other containers, plastics into different types, and glass into different colors. The scanners work best with materials already presorted into fewer categories and separated from each other. For example, while some scanners can sort paper and others can sort glass, neither can sort glass from paper.

Optical sorters currently work on variations of two basic designs. Both recognize different features (such as glass color) as the material moves by a scanner on a conveyor belt at constant speed. Once recognized by the scanner, a jet of air can blow the selected item out of line so it is separated. Or, if the pieces being separated are too heavy to be moved by the burst of air, then the air can be used to activate a mechanical finger that will move the particle to the separate stream.

Manual Labor

Few processing facilities in North America rely heavily on manual labor anymore because high labor costs make processing too expensive. Machinery, while initially expensive, ultimately lowers the cost of processing per ton of materials as long as it is appropriate for the volume of materials processed. But the correct mix of manual labor to machines is still essential for a processing facility to operate with best practices.

Some processors have found that mechanical sorting produces a more consistent quality than manual sorting, although not necessarily a higher quality. Mechanical sorting is not as dependent on having a full complement of workers, nor on those workers performing to the same high quality standards all the time. At the same time, MRFs cannot run effectively without enough manual labor for equipment maintenance, making sure that the equipment is operating properly, and hand-sorting some materials.

Each processing system is designed to be operated under optimum conditions by a staff of a given size. However, the optimum conditions are rarely met, so additional staffing should be planned for, to correct for the difference.

Processing equipment needs constant maintenance and if that is not provided the MRFs sorting capability will decline. If star screens clog up they will not be able to function properly. If the lenses on optical sorters get dirty, they will not be able to perform as designed. Similarly, if the MRF depends on workers to pull out materials at picking stations and some are missing – whether because of labor reductions or of insufficient planning to cover workers who are out because of illness or other events – then dirtier materials will come off the lines.

Highly mechanized MRFs also require more highly skilled workers than low-tech facilities. While mechanization may reduce the need for manual labor, it increases the need for workers skilled enough to keep the equipment operating properly all the time.

Staffing must match the design capacity. Typically, when budgets are tight, the first response is often to cut staffing. In contrast, once purchased, it is hard to cut back on equipment or lease

payments. Staff costs are more flexible. However, the MRF will not be able to produce high quality materials if there are not enough staff to ensure its effective operation.

SORTING

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

While the types of equipment used make an essential contribution to successfully sorting materials, their configuration can either maximize or reduce their effectiveness. 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.

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

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

A pre-processing area will provide the best opportunity to remove items that may create a problem on the processing line, such as tangles of wire (like 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 large disk or star 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 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 create 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 only removes unwanted materials (contaminants), leaving the desired materials in the system. For example, the sorting process can be designed to pull out newsprint from the commingled materials, as a positive sort. On the other hand, it can be designed to screen out glass, plastics and metals in order to create cleaner and cleaner newsprint as it travels down the conveyor belt. This negative sort is intended to result in uncontaminated newsprint by the time it arrives at a baler or fills up a truck as loose paper.

Burden Depth and Belt Speed

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 line.

Properly sorting materials is most effective when they are spread out on the process line so that equipment or pickers can accurately identify and route the different materials to the correct stream. If, instead, the depth of materials is too great, many contaminants get through to the end product.

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.

The depth of material loaded on the conveyor can be reduced if the amount of equipment purchased is designed to appropriately handle the actual facility throughput. The design should include a margin for peak loadings, increased tonnage from population and program growth.

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

Once each type of material has been sorted from the primary pile, it may go directly to a baler or be loaded onto a truck for delivery to market. But frequently it passes through an intermediate temporary storage area. These may be bunkers, bays, hoppers or debris boxes.

Bunkers with fixed floors are emptied by loaders pushing the separated materials on to the next process line. With paper, generally this is a conveyor that takes the paper to a baler. Some bunkers have self-unloading, moving floors. If hoppers or debris boxes are used for storage, these are usually dumped mechanically. Hopper doors are opened and the bin is tilted (or may have a tilted floor) until the materials empty out. Debris boxes are moved into place and dumped either with a forklift or on a roll-off truck.

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 whole point of processing at the MRF is to remove contaminants from the commingled materials while sorting them accurately back into clean feedstock streams appropriate for use by a manufacturer who will convert them into new products.

Of course, good program design and high quality processing should result in low residue rates, assuming that the incoming material was not heavily contaminated.

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. For example, when San Jose, California's single stream program first started, one of its two MRFs had a residue rate approaching 40 percent for the first year. This was not because the materials delivered to that MRF were unbelievably dirty. Rather, a combination of poor processing design decisions as well as problematic contracting relationships and lack of employee training led to huge amounts of the collected recyclables being lost to disposal. Essentially, while about 10 percent of the incoming material were contaminants, almost 30 percent of the recyclable materials collected for recycling were being treated as garbage. Intensive remedial work on the MRF and in other program areas reduced that high residue rate by two-thirds the second year.

Everyone would agree that a 40 percent residue rate is much too high, but what is a reasonable residue rate for a single stream MRF? This is difficult to pinpoint exactly because residue rates are subject to a number of variables. If the loads set out by the resident are badly contaminated, then the residue rate will be higher. If the loads set out by the resident are clean, then a high residue rate can usually be traced to bad processing. Generally, the residue is a combination of these two factors.

Good source separation recycling systems report residue rates of 2 percent - 4 percent, while many single stream processors report rates from approximately 5 percent – 10 percent. When single stream MRF residues are below 10 percent, it usually means that the recycling program is marketing more recyclable materials than were being recycled before the single stream program was implemented.

Low residue rates also require having the right equipment in the right places in the system. For example, a magnet to remove steel/tin cans placed at the beginning of the sorting line will have a hard time recovering all of the cans through the initial heavy layers of paper. The magnetic separator will do a much better job of recovery if it is located after the containers have been separated from the paper.

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. However, this is not the true residue rate.

To correctly calculate the rate of each of the three types of residue described above, 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.

In some states, glass is said to be recycled if it is used for alternate cover at the landfill, or as part of the landfill site construction activities, where the glass replaces aggregate, including fill around the methane recovery system pipes. Material that goes off for this kind of very low grade “beneficial reuse” is not traditionally counted as residue but should also not be counted as “recycled.”

Recyclable materials that are shipped off to the wrong place are often not counted as residue where they are processed, but may become waste at their destination. For example, plastic bottles shipped in a bale of paper to a paper mill and then disposed of by the mill should be counted as part of the residue of the MRF that shipped the paper bale. However, these materials are generally not tracked and, indeed, the MRF almost always counts them as part of its diversion rate. If their disposal is accounted for at all, it is almost always registered against the manufacturer's jurisdiction, when actually it should be deducted from the shipping jurisdiction's diversion rate.

Communities should require their processor to receive information from the markets that purchase their recyclables that includes the amount of "prohibitives" (materials that were not appropriate to their process and have to be discarded) received by the mill. These tonnages should then be calculated as part of the MRFs residue rate.

In assessing a processor's true residue rate, the municipal government recycling program managers should, at a minimum, require the processors to report:

- Whether the manufacturers who receive the MRFs' materials regard them as high quality. Do these materials meet the quality specs of the mill? Contaminants that are inappropriately shipped to a manufacturer should be counted as residue.

- The millage loss reports from manufacturers who bought the processor's materials. This type of report is not yet common. But with recovered material contamination rates at some paper mills running at 20-25 percent of received materials, this is critical data to use in evaluating the success of a processing facility. Paper, plastics and glass manufacturers say that they track this information for their own internal evaluations and can provide it to recycling programs – sometimes by individual MRF, other times by jurisdiction or state. It can be reported to processors or to state or municipal governments.

- Whether the MRF ships mixed materials (such as plastics or glass) to another facility for additional processing. This may be efficient, but it may also mask the true residue rate if the contaminants from the shipped materials are disposed of at a distant location. Up to 70 percent of some loads shipped to glass re-processors are landfilled because the material is too contaminated. Additionally, the loading and reloading of materials may increase residue and loss of valuable recyclables.

- What happens to each of the material types shipped to market (or not shown as disposed), especially the lower value commodities, including #3-#7 plastics and glass containers.

- If the residue (often predominantly glass) is counted as diverted or disposed. (Some communities consider residue used for alternative daily cover at landfills to be "diverted.")

Communities should require that processors receive reports from buyers of each commodity on the quality of the materials shipped to each manufacturer and that copies of these reports be provided to the community.

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 their 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

How can an individual government calculate their diversion rate when they share a processor with other municipalities?

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 to sample the materials received from their program on a monthly or quarterly basis and then 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 use, the processing line should be designed to recover each material type before it is degraded by the processing system.

Most materials are degraded by broken glass, and breaking the glass reduces the ability of the processor to remove contaminants from the glass. Therefore, much of the concern about the quality of the processing system and the quality of the recovered materials centers around handling the glass.

Additionally, 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 MRFs.

Part of the ability of the MRF to process the recyclables to the quality standards sought by the mills relies on operators not exceeding the processing capacity of the equipment. In almost all cases, reducing the amount of materials processed per hour will improve the quality of the end product. This may mean that more labor and equipment will be required, but best practices require that quality come first.

Capacity

Each processing facility is designed to handle a maximum tonnage of a specific composition of materials. The processing facilities producing the poorest quality are often running well over capacity, although there are often other factors that affect their quality, as well.

Equipment capacity ratings are based on the ability of the machinery to process a product to a given standard. Ratings are based on ideal conditions that are rarely maintained for long periods of time.

For example, a star-screen that is rated at 20 tons per hour is supposed to be able to move 20 tons per hour across the screen and remove all of the materials that are smaller than the screen openings. When run at this throughput level, the burden depth of the material is expected to be appropriate for all the small pieces to fall through the screen openings, with none passing beyond the screen.

However, a variety of conditions may keep this from happening. Capacity ratings are based on a consistent flow of materials, not an uneven distribution. Therefore, if the burden depth varies, the screen may function properly some of the time and not at other times.

Additionally, if the screens become partially clogged by materials they were not designed to process (such as long stringy items such as electrical cords or textiles), the screens will likely not perform as rated. And, if the paper is wet and clumps together instead of spreading out, the screens may not be able to properly separate the fines from the larger materials.

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

This can best be accomplished by running multiple identical 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, even if the equipment is relatively new and "high tech." The new large facilities may receive widely different materials if they serve multiple communities (potentially with different lists of targeted recyclables) or 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. What can they do to ensure quality processing for their materials?

The community 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 considerable flexibility to handle very different streams of recyclables, similar to collections in a large community with very diverse neighborhoods.
- Work with the other communities that use the same MRF to achieve consistency of program design across jurisdictions. The community of Oakland, California, for example, is working with neighboring jurisdictions to create more compatibility between their programs over time.
- 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 collected materials in separate areas and process them separately and sequentially, if possible. It may also help to run the processing lines at slower speeds, to reduce the amount of material on the conveyor belts, or change the angles on the sorting screens to adjust for different characteristics of the materials.

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, of 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 disc 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, if a single stream program is introduced to a community with a recycling program that previously 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.

For example, for commercial loads it may be necessary to have an OCC screen that would not be used for a residential sort, or run the system to deal with more shredded paper, or slow the system down to deal with higher levels of glass from bars and restaurants.

However, even if source separated materials are not collected from commercial waste generators, the 'single stream' commercial collection recyclables should still be processed separately from the residential materials because of the materials' composition differences.

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, serving community service sentences, and prisoners, 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 expenses connected with them. Police and prison guards to supervise prison labor are expensive, increased injuries to some groups increase already high workers comp rates, there is a long learning curve in sorting some material types, and the inconsistency in the ability of the workers makes it difficult for MRFs to produce consistent quality 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 MRFs capacity does not double its operating costs. Equipment designed to process 20 tons per hour is not twice as expensive as equipment designed to process 10 tons per hour. Small facilities may not process sufficient tonnage to operate full time, to amortize the equipment costs, or to afford at least minimum staffing levels. Some smaller facilities (e.g. processing less than 20 tons per day) have recognized that high tech equipment does not make economic sense for their program and have therefore elected to maintain dual-stream programs instead of single stream, 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." This is a result of changes in the global marketplace.

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.

Despite the expensive, high-tech equipment that may be in a processing facility, MRF costs are very minor compared to those of many recycled product manufacturers. A typical MRF may cost considerably less than ten million dollars ($10,000,000), while a moderate-sized newsprint mill is likely to cost several hundred million dollars.

When recyclers consider single stream processing from a whole recycling system perspective, it is obvious that the responsibility for properly sorting materials in a cost-effective way rests squarely with the MRFs. Even though in most cases they are separate companies, optimal recycling system functioning calls for them to operate as reliable partners with manufacturers in order to ensure the highest quality and most competitive finished recycled products.

One way to provide incentives to the processor to clean up materials to higher levels than may be rewarded by the open market is to include financial benefits in the contract for meeting the community recycling program's larger goals. (See *Chapter 8: Contracting*, for further details.)

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 always be made 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 services.

Communities can benefit by following a two-part contracting process simultaneously. This includes releasing a Request for Proposals and Specific Contract Terms at the same time, not sequentially, and having the proposers return the signed Agreement with their Proposal. There should also be provision for the proposer to suggest options to improve their proposal, but these changes would be provided at the sole discretion of the community. This reduces the need for extended negotiations, but allows the community to make whatever changes they think will improve the quality of services provided.

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 so many variations on relationships with collectors, processors and end-users that each contract will 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.

Questions to Answer Before Preparing An RFP or Contract

Answering a series of questions before writing the contract will make it easier to ensure that the subsequent language will get the results you want.

- ***What are the community's recycling and diversion goals?*** Does the community have an interest in making sure that the Contractor sells the recovered recyclable materials to markets that make products similar to the ones collected? What are residents' expectations for the use of their recyclables? Does this influence the choice of markets?

- ***What materials should be recovered?*** *Are there good markets for these materials? What impact does adding each have on the overall collection and processing system?* The fewer the number and types of materials collected, the easier it is to process them back into high value commodities. It is also easier to explain to the residents what you want them to put into their recycling cart. On the other hand, including a greater number of types of materials can increase the recycling rate.

  Many communities are finding that if they accept all plastics, they recover more PET and HDPE than when they only accept PET and HDPE. Apparently many residents do not bother to separate the plastics if the community only takes some types and they do not want to check to see if theirs is the right kind.

- ***What is needed for the community outreach and program promotion?*** No one message will appeal to everyone, so it is important to prepare multiple messages. Different messages should be targeted to different groups – young and old, educated and not, rich and poor, consumers and savers, etc.

- ***What kinds of collection containers and carts will be used? Should collection be manual, semi-automated, or fully-automated?*** The use of carts in collection has become the best way of reducing worker injury from lifting.

  The size of the carts, bins, or residents' own containers can be important in establishing the recovery rate for recyclables. When communities collect garbage in large carts and recyclables in small bins, the message to the resident is that "We don't expect you to recycle very much." When the capacity for recycling is at least equal to the capacity for garbage, the message is "Recycle at least half of your wastes."

  San Diego uses a 90-gallon cart for recycling and a 90-gallon cart for garbage. While this configuration does not send the signal to reduce the amount of waste and recycle more, it does mean that residents have sufficient garbage capacity to not contaminate their recyclables.

  San Francisco uses 32-gallon carts for both garbage and recyclables as their default container size because of the small lot sizes in the community.

  San Jose chose to use 96-gallon carts as their default containers for recyclables but 32-gallon carts for garbage. While this clearly sends the message that residents can save money on their garbage bill by recycling more, they have the highest contamination rate of the major cities in northern California. When the small garbage cart fills up, there is no incentive to pay for additional service because the resident can just throw the overage into their recycling cart.

- ***Will recyclables and garbage collection be with one split body truck or two separate trucks?*** Split body means that only one truck is required to go down the street to collect both recyclables and garbage. When collecting two types of collections on the same truck, there is more likelihood of mixing materials.

  Using one truck dedicated to each collection type means that two trucks are required, but the recyclable materials will be cleaner and the driver's job more straightforward.

  If the recyclables and garbage are off-loaded at separate locations, then using a split body truck means that the driver has to go to two separate locations to dump the materials. If they are very far apart, this will cause the system to be less efficient.

- ***What market specifications will be required for materials shipped?*** The community should specify in the RFP that they want the processor to market the recovered recyclables at the highest possible quality and for high-level uses that maximize the materials' subsequent recyclability.

  For example, the community could specify that the processor sell container glass to glass container manufacturers, and that the glass meet the specs of that industry or a specific buyer in that industry.

Proposers should be asked to provide details on how the recovered materials will be marketed. This would include details on how the materials will be processed, the specifications that will be achieved for each material type marketed, and the buyers for each of those commodities.

This can be based on existing contracts or general relationships that the processor already has with specific buyers. It should include information on feedback that the processor has received from the commodity buyers.

The proposer should agree to (continue to) meet the specifications of those buyers, and provide the community with assurances that they will do so.

- ***What are the required staffing and equipment levels to meet those market specifications?*** Proposers should be asked to provide details on what staffing and equipment levels will be required to meet the market specs requested by the community, and to provide assurances that the processor will provide that level of staffing and equipment to meet those specs throughout the term of the contract.

- ***What are the collector, processor and market relationships?*** The proposer should be required to describe their existing relationships with buyers of materials that will be recovered in this program and provide references for each material type to be marketed.

- ***What are manufacturers' roles in materials specifications?*** If specific markets are identified for each material type, the proposer should include in their proposal a set of specifications that were provided by the buyer of the material, along with a commitment to meet them.

- ***What is expected for contamination and residue definitions and rates?*** 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.

  The specs to be provided should include information on allowable and unacceptable contaminants and residue rates. The processor shall provide definitions and rates to be achieved for each contaminant and residue type.

- ***What reports are required on materials marketing?*** In addition to reports on the tons recovered and tons marketed, the community should require that the processor report on contamination levels achieved, both through sampling at the processing facility and in reports from the buyers of the materials.

- ***What is expected for revenues from the sale of recyclables?*** They can offset a large portion of the cost of service but should not be expected to cover the entire cost. The higher the quality of the recovered materials, the higher the revenue that usually can be expected.

  Single stream recycling programs generally report that 75 - 80 percent of the materials recovered in a single stream recycling program is paper. If the paper is clean and sorted to the specifications of high value end users, the program can realize significant revenues from the sale of paper. If the paper is contaminated and sold as a lower mixed grade of paper, these revenues will be lost and the rate payers will have to make up the difference.

Revenues from other high value materials can be lost to the community if materials are poorly sorted, and aluminum cans and plastic bottles are shipped to paper mills in paper bales instead of being shipped to the appropriate markets.

When glass bottles are not recovered for use in glass container or fiberglass manufacturing, the value of the glass is either reduced to that of aggregate, or is lost altogether.

- ***How does the community intend to handle risk and revenue sharing?*** Generally, local governments are risk adverse and prefer to make consistent payments to their contractors. They usually do not want to share the risk that the projected revenues may not be realized and therefore are not willing to make any additional payments to the contractor if the market revenue does not meet the projected revenue.

  Therefore, to be fair to the contractor, the generally accepted practice is to let the processor keep all revenues above the agreed upon amount. This provides the contractor a little more incentive to provide high quality materials to their buyers, because the extra cost of cleaning the materials may be recovered through the higher revenues.

  When communities ask the contractor to share some of the extra revenues, the marketing incentive of the contractor is reduced, but not eliminated.

  Before asking your contractor to split the excess revenues, determine what will happen to the additional revenue when it is received by your community. In most cases, it is too small an amount to return to the rate payers and goes into the General Fund, where it is not available to offset program costs. However, if these revenues can be directed, for example, to program promotions activities or to monitoring contamination, then there may be some direct benefit to the revenue sharing arrangement.

- ***What kinds of incentives and penalties will be built in?*** Incentives for achieving goals, higher pay for higher recovery rates? Penalties for non-performance standards? Penalties for not meeting program goals? Penalties for high processing residue rates?

- ***What is proposed for cost of living adjustments?*** What are the fixed and variable costs during the term of the contract? Equipment purchase or lease costs are fixed. Fuel and labor costs are variable.

- ***How will changes to the contract be handled?*** How can you add other material types or increase or reduce service? How can you change your contract before the agreement ends?

  If your program already has an ongoing contract, you will need to negotiate the desired changes with your service provider. If there are to be significant new equipment purchases, the contract should be extended to cover the standard depreciation or amortization schedule for that equipment. If your service agreement is due to end soon, it may be easier to wait until you go back out for service proposals to make major changes to your program.

CONTRACT SPECIFICS

Communities typically specify the services that they want from their contractors. Single stream collection systems 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. If communities also specify in their contracts that they want materials produced to a high level of quality, then the contractor

will have to factor the cost of this service into their price, just as they do for the rest of the system, to achieve the goals of the community.

Contracting for Collection Services

The collection contractor(s) may have one of several different relationships to the municipality.

Collectors can be municipal employees, or can be employees of a private company.

- **Municipal Collection** - It is much more common for the collectors to be community employees in the Eastern U.S. than in the West. This is partly because garbage collection services were provided as a matter of public health and safety by the older cities before the private garbage collection industry developed.

- **Franchise Agreements -** The community may set conditions on the collection of garbage and recyclables in their community as a way to maintain public health and safety. Three common arrangements are:

  No Franchise Agreement - A community may choose to not regulate the collection of garbage and recyclables in the community, so any hauler may collect these materials. This feature is common in the commercial sector of larger communities but is rare in the collection of residential wastes.

  Exclusive Franchise - Smaller communities that contract for collection services often make exclusive arrangements with their hauler because there is not enough business to support multiple contractors.

  Non-exclusive Franchise - A non-exclusive franchise allows multiple haulers to provide services as long as they agree to certain franchise conditions set by the community. This feature is primarily used in the commercial sector. Frequently contractors are required to pay fees under these agreements, while they do not pay fees where there is no franchise agreement in place.

Contracting for Processing

Processing can be provided by staff of the community, by the collector of the materials, or by a third party either under contract to the community or to the collector. The processing facility can be owned by any of these parties, and operated by any of them.

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 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 the processing and include:

- Specifications on types, composition and quantities of materials to be received and the schedule for receipt of those materials
- The hours of operation of the processing facility
- The commodity types to be recovered and marketed
- The quality of each of the commodities to be marketed
- Details on how the recovered material will be marketed
- The equipment and staffing to be provided by the processor for the tonnage projected, and mechanisms to adjust equipment and staffing 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 product specifications
- Other specifications as appropriate to local conditions.

If standards are not in place at the beginning of the contract to cover these issues, the community may not have an appropriate mechanism to correct problems as they occur.

As a general rule, communities contract with their collectors for collection and processing services. The collection services are specified in some detail, because that is the interface between the community's collector and the residents. These contracts may also have language about the residue from the processing facility and how it is to be handled. But these contracts rarely specify much about the processing of the materials.

You may be contracting with the collector who also owns the processing facility or has an existing contractual relationship with it. In that case, it is important to be able to distinguish the actual costs of the processing services that you are requiring. This is best done with an audit of actual expenses incurred. Communities are likely to best be served by paying a fair amount and requiring that at the end of one full year of processing, the processor demonstrate their 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).

The community of San José allowed its collection contractor to hire a subcontractor to process the collected materials. The community placed the burden of processing on the collector, but the collector, in turn, did not sufficiently specify what it required in its agreement with the subcontractor. This resulted in the community having to penalize the collection contractor for lapses in the processing of the community's materials, while the processor who failed to meet the terms of the community's contract with the collector did not receive any of the penalties or incentives that might have encouraged a different outcome.

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 subcontract language to ensure that it meets the community's needs. Any performance incentives or penalties should affect the subcontractor as well as the contractor.

To best manage the processing contract, the contractor should regularly report on those items that are specified in the contract, including:

- Number of tons received,
- Number of tons of prohibitives and residue disposed, and their composition,
- Report at intervals (monthly, quarterly or semi-annually) on samples of the incoming materials to determine the amount of prohibitives (non-recyclable materials that are received) and samples of the residue to determine the amount of recyclables in the discards,
- 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 that just 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 usually result in higher revenues to off-set 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 ration contracts), the contractor may actually increase their profits by processing to a higher level.

Assuming that the processing requirements are required of all companies that bid on providing the services, then the bids will all be on the same terms.

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.

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 does 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.

OTHER CONSIDERATIONS

Contractors' Compensation

In the most common form of contract, the contractor is paid a flat fee per household served for collection and processing. This formula does not provide the contractor any incentive to increase diversion.

One alternative is to pay the contractor a small amount per household served, and an additional amount for each ton of recyclable material marketed.

The next level would be for the payments to be higher for higher value markets, to stimulate a higher degree of processing.

Market Incentive Example:

For services rendered, the Contractor shall be paid $10.00 per household served per month. Additionally, the contractor shall be paid $20.00 for each ton of recyclable materials sold to a manufacturer within 20 miles of the community center, and $10.00 for each ton of recyclable materials sold to a manufacturer located more than 20 miles from the community center.

Local Markets

Some communities might have local manufacturers they want to support for economic development reasons. The contract could include language that would allow the community to direct the materials to a market of their choice, with community compensation to the contractor for any revenue loss that the contractor could document (with reduction for the cost of transportation savings).

Financial Implications of Different Contracting Options

Most cities want to eliminate their own financial risk and have a constant, predictable payment to the contractor. It is hard for communities to budget for extra payments to a contractor (the standard contract for services is based on an 'amount not to exceed').

This means that they structure their contracts to pay the contractor a flat fee, and if there are higher than projected revenues they fall to the contractor. If the revenues do not equal projections, the contractor's profits are reduced.

Communities may also stipulate that if revenues exceed an agreed-to amount, then some percentage of the extra revenue will be paid to the community by the contractor. This allows the community to protect against the contractor receiving 'windfall' profits. But generally communities are not willing to share the risk with the contractor if there is an equal amount of revenue shortfall.

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.

APPENDIX 1: GLOSSARY

COMMODITIES TERMS FOR RECYCLABLE MATERIALS

HDPE – High density polyethylene plastic

LDPE – Low density polyethylene plastic

MP – Mixed Paper

OCC – Cardboard – Old corrugated containers

ONP – Old newspaper

PET – Polyethylene Terephthalate plastic

DESIGN TERMS

Single stream 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.

PROMOTIONS TERMS

Notice of Inappropriate Setout – a tag to be left by the collector if recyclable materials are not properly prepared.

Notice of Non-collection – a tag to be left by the collector if recyclable materials are so badly prepared that they can not be collected without contaminating other materials that have already been collected.

COLLECTION TERMS

Bin – a small open container used by a resident to store recyclables for collection

Cart – a larger, wheeled and lidded container used by a resident to store recyclables for collection. The additional capacity reduces the number of times per month that the resident needs to put recyclables out for collection, which reduces the number of times the driver must stop en route.

Automated Cart Collection – The collection trucks include equipment that automatically lifts the containers so that drivers do not have to empty them manually. Types of automation include:

Fully-automated – The driver does not need to exit the cab of the truck, but activates a mechanical arm to grab the cart, dump the contents into the truck hopper, and return the cart to the designated location. One driver can collect from more homes in a day in a fully-automated system than in a manual or semi-automated system.

Semi-automated – The driver must exit the truck, attach the cart to a dumping mechanism, activate the dumper, return the empty cart to the designated location and then re-enter the truck cab. One driver can collect from fewer homes in a day than a fully-automated system, but about the same number as in a manual system.

Manual Collection – The driver must exit the truck, lift the recycling bin and dump its contents into the hopper on the truck, return the empty bin to the designated location, and then re-enter the truck cab. One driver can collect from fewer homes in a day than a fully-automated system, but about the same number as in a semi-automated system.

Split-body truck – One collection vehicle with two or more compartments, so that more than one material type can be collected in a single pass. Two compartments trucks are most commonly used to collect garbage in one compartment and recyclables in the other; but may also be used to collect fiber in one compartment and containers in the other.

PROCESSING TERMS

Materials Handling terms include:

Contamination – Four types are listed below:

- **Non-Targeted Materials** – Materials a community does not ask its residents to set out for recycling. Some of these materials are recyclable when appropriate processing is provided and when they are accumulated in sufficient quantity; some are not recyclable.
- **Out-Throws** – Materials that are removed from materials being processed by a manufacturer because they are not appropriate as feedstock materials for the product being produced. Out-throws may be recyclable, but still be disposed of in a landfill if they are shipped to the wrong manufacturing facility.
- **Prohibitives** – In manufacturing, a material that causes damage to the product being manufactured, or to the equipment making the new product.
- **Residue** – Left-over materials from processing that are not destined to be made into new products, but will be disposed at a landfill or used at the landfill for normal disposal operations.

Targeted Materials – The list of materials a community asks its residents to set out for recycling, and for which the community contracts for collection and processing.

Processing Facility terms include:

Processing Line – the sorting equipment used to separate mixed recyclables

Tipping Floor – The area of a processing facility where trucks unload

Materials Separation Equipment terms include:

Air Classifier or **Air Knife** – Air is blown through (at right angles to) a falling stream of materials, and the lighter (less dense) items are blown farther than the more dense items so they can be sorted by type. For example, pieces of paper labels can be removed from broken glass.

Air can also be used to separate materials as they move along a conveyor. The air is blown into the material while it is moving in the same direction as the air flow. New optical paper sorters use air to spread the paper out for the sorters to identify individual sheets.

Bounce-Adherence Sorter – On a slanted vibrating table, objects with different shapes are separated by motion

Conveyor – A device to move materials from one place to another. Conveyors are typically horizontal (flat) or inclined. Flat conveyors are used for picking lines, where employees pick specific materials from the line, and inclined conveyors are used to bring material from one level to another. Typically, material falls off the end of the conveyor, onto another conveyor, or into a large container.

When material falls off one conveyor onto a conveyor going in the opposite direction, it tends to flip the material over, so that the bottom of the pile from the first conveyor is on top on the second conveyor. This technique may allow sorters and screens to do a better job of separating materials by type or size.

Densifier [balers, compactors and crushers] - To compact a load for shipment to an end market, additional processor, or landfill.

Disc Screen – A screen with parallel rotating shafts that have discs mounted perpendicular along the shaft's length. Adjacent discs form openings. The discs lift materials and move them along in the direction of the turning disc. Smaller items fall between the discs and larger items pass over the surface. The spacing of the discs determines which size material separations occur on the screen.

Eddy-Current Separator – By combining alternating magnets, the force field repels non-ferrous metals, and will readily separate aluminum cans from other non-metallic materials (such as plastic bottles).

Finger Screen – Vibrating bars that let small items fall through, between the fingers; while larger and flat items continue on. Finger spacing can vary to allow separation of different size items. Finger screens do not break glass bottles and tend to handle stringy materials such as wire and stretch film better than disc screens. If the burden depth is too great, the fine materials will ride along on top of the flat materials, so the screen does not do a good job of separating materials by size.

Low-impact Sorter – These sorters are designed to separate flat items (paper) from round or cylindrical items (beverage containers). They do so by having a short conveyor belt with short cleats at a steep incline. The belt moves at a high speed, and the flat items are conveyed upward, off the end of the belt, while the 3-dimensional items bounce off and are collected below the inclined belt

Magnet – Uses magnetic forces to separate ferrous metals from other materials

Optical Sorter – Sorts materials by their optical properties, can be used to sort fiber by color (kraft brown from other, white from colored) or glass by color (clear, green and brown; or opaque from transparent) or plastics (such as natural HDPE from other plastics)

Oscillating Screen or **Vibrating Screen** – A sorting surface where materials are separated as they move along a surface with holes.

Roll Screen – A modified disc screen, where the discs are triangular, instead of round. This causes a pulsating movement, and may provide better separation of materials than a simple disc screen, depending on the nature of the materials being processed.

Star Screen – A modified disc screen, where the edge of the disc has fingers. The star discs move more material along than simple discs, and allow for better separation of materials.

Trommel Screen – A large metal cylinder with holes in it to allow some items to be separated from larger items that do not pass through the holes. Longer trommel screens can have smaller holes at the in-feed end, and larger holes further along to make more than one size separation.

Vacuum – A vacuum is used to lift lighter materials from a sort line, leaving the heavier materials on the belt. For example, plastic bags can be removed, leaving paper and beverage containers behind.

APPENDIX 2: LOW IMPACT PROCESSING TO RECOVER GLASS

COLLECTION

To insure that more of the glass will be available to be returned to its highest value use, it is important to minimize the breakage at the early stages of processing. A primary cause of glass breakage in the collection vehicle is glass being dumped into an empty [steel bottom] hopper. To eliminate this situation, it may be possible to raise the hopper packer blade about one inch by welding strips on the bottom sides of the packer blade, and thereby leave a layer of paper on the floor of the hopper to partially cushion the glass as it is loaded.

UNLOADING

When the truck arrives at the processing facility, the materials should not be unloaded onto a concrete tipping floor, but instead the recyclables should be unloaded onto an in-ground rubber conveyor. The in-ground conveyor shall be long enough to move a load away from the truck while it is unloading [about 90-feet long]. The recyclables from the in-ground conveyor would be metered and spread out onto an elevating conveyor to take them up to the flat-round separator' so that they do not overload the separator. It is important that the materials are moved to the 'flat-round separator' before any other processing action is taken. Large items that do not fit into the wheeled cart (cardboard) should be loaded into a separate compartment on the truck, and then unloaded in a separate area so they do not reduce the effectiveness of the processing equipment.

MATERIALS STORAGE

Unloading the truck directly onto a conveyor will eliminate the need for a bucket loader to push the newly arrived materials into a large storage pile, which is the primary system design that breaks the glass before it can be separated from the paper. This also means that the glass is separated from the paper while contaminants can still be removed, and while most of the bottles may still be sorted by color.

MATERIALS SEPARATION

The flat-round separator works by moving the flat materials [including paper, film plastic, and flattened beverage containers] up a steeply inclined rubber belt with short cleats. The round materials [primarily beverage containers, but also bundled paper and phone books, and 'bag-in-bag' plastic film] fall down onto another conveyor belt below the separator.

The flat materials are moved up over the top of the separator and then can be screened to separate any small flat items from the larger newspaper, paperboard and cardboard items. The clean paper can then be stored for processing at a later time without fear of contamination, or can immediately be sorted by grade, and to remove film plastics. The small items from the flat separation, including flattened beverage containers and small pieces of paper, can be added in with the round item stream for further processing.

The round materials that fall off the separator are conveyed on, in-line with the infeed conveyor, to further minimize glass breakage. A magnet can be used to separate the ferrous

materials from this mix. Then an air classifier [blower] can be used to separate the light weight materials [shredded paper, aluminum and plastic] from the glass.

The light fraction can be further sorted by using screens to remove the fines (especially broken glass), and an eddy current separator to remove the aluminum cans. The remaining plastic bottles can be sorted by grade and type (or shipped to another facility for further processing).

The heavy fraction is primarily whole glass bottles and large broken pieces. Contaminants (including Pyrex™ and other heat sensitive glass, ceramics and rocks) can be hand picked from the glass bottles before any further breakage occurs. This feature insures that the glass will be clean enough for the glass container manufacturers to be able to use it in the production of new bottles and jars.

Then the glass can be optically color sorted. Although it has not already been done, it should be possible to sort the whole bottles and large pieces of glass by first aligning the bottles, and then size sorting them before conveying them to an optical sorter. The sorter would use a camera to view the glass coming by on each line, send a signal to a computer that would activate a mechanical finger to remove the bottle from the primary line and push it onto a secondary line. Small, broken pieces can be sorted by another optical sorter.

One major benefit of using this low impact separator instead of a disk screen or star screen is that there are no rods to wrap with film plastics or other elongated materials, thus reducing the required maintenance.

Overall, this system may require more space and more equipment than systems designed to break the glass first. This is to provide sufficient capacity to initially process the materials as they arrive. However, some of the equipment is less expensive than that used in the current systems, and will provide a higher quality product. Additionally, this system may require less maintenance than the systems currently being designed.

APPENDIX 3: SAMPLE CONTRACT LANGUAGE

REQUEST FOR PROPOSAL LANGUAGE

Summary of Intent

Materials are to be collected and processed in a manner that maintains quality throughout their handling.

The recovered materials are to be marketed for the highest value use feasible.

Collection Issues

Collection of recyclables shall be performed with a separate truck than collection of garbage.

The collector and processor should identify materials for which there is a feasible market, and request that the community not offer to collect from the residents materials for which there is no viable market.

The collector shall provide the community with a 'contaminant level reduction plan' that delineates driver and route supervisor roles and responsibilities that will be used in addition to the community promotions program.

Where semi-automated or fully- manual collection systems are implemented, the driver shall be responsible for inspecting recyclable materials set out for collection by the residents, and for not loading contaminated materials into the collection vehicle. The driver shall leave a notice of improper set-out attached to the recyclables container for each load not collected.

Where fully automated systems are implemented, all collection vehicles shall be equipped with devices to assist the collector in identifying contaminated materials as they are loaded onto the collection vehicle. This shall include mirrors mounted above the hopper so that the driver can see the load as it is dumped from the cart, or a closed-circuit camera mounted above the hopper with a monitor in the cab for the driver to view the load, or a similar device.

It shall be a requirement of the proper performance of the driver to use the tools provided to identify contaminated loads, and to provide the resident with a notification that the load was contaminated.

The route supervisor shall regularly meet with the driver to discuss contamination in collected materials.

Processing Issues

The Collection Contractor shall deliver the collected recyclables to the designated Processor. The Processor shall separate the commingled materials by type, such that the Processor can sell the materials for their highest and best use.

NOTE: The proposer should be required to provide a detailed facility design. The description of the facility should include steps to be taken in processing, the capacity of each element or system used, and how quality will be maintained.

NOTE: The community should require the collector to identify whether they will process the collected recyclables immediately following collection, or whether the collector will need to transfer them to another facility for processing. Each level of handling reduces the quality of the materials sent to market, so a preference will be given to direct processing.

Residue Rate Calculations

To determine the recovery rate for the processing facility, the operators will be required to:

- Sample incoming materials for overall composition and to identify contaminants and non-targeted recyclable materials that are received at the facility.
- Sample the residue that is being directed to landfill to identify the overall composition and specifically to identify all of the recyclable materials in the residue.
- Sample fully processed materials that are to be marketed to identify contaminants and recyclables that are being misdirected to manufacturers that cannot use them.
- Receive reports from each manufacturer or secondary processor describing misdirected recyclables, including process loss and millage loss reports by material type.

The Proposals should specify:

- The process residue levels to be achieved.
- Programs that will be implemented to reduce the amount of recyclables in residue if the contract levels are not achieved.
- Programs that will be implemented by the processor to reduce the amount of misdirected recyclables if the contract levels are not achieved.

Revenues

The proposal cost calculations must state whether revenues received by the contractor from sale of recyclables shall be used to offset the cost of collection and processing of the recyclables.

Revenues received from other sources, including special funds (in California there are revenues from the State for statewide programs including beverage container redemption and processing, used motor oil collection and scrap tire collection) and grants, shall be accounted for in the calculation of costs of operating the program.

Materials Marketing Issues

The proposer shall include a list of markets to which the recovered materials will (at least initially) be sold.

The proposer shall include with their proposal the quality specifications requested by each manufacturer that will convert the recovered recyclables into new products, for each material to be marketed.

The proposer shall commit to process the received materials to meet the specifications of the mills to which their materials will be marketed.

Promotions Issues

NOTE: In addition to the promotional materials listed to be provided by the community, the contractor should be encouraged to provide details on promotional materials and activities that they would recommended the community undertake, and activities that they would undertake to contribute to the success of the program.

CONTRACT LANGUAGE

This section is not intended to provide a complete description of contract language for collection and processing systems, but just provide some specific options relating to the needs of single stream collection programs.

Collection of Recyclables

Contamination – The driver shall not collect contaminated recyclables. Contaminated recyclables shall be defined as those containing more than incidental amounts of garbage, and those containing materials listed on the not-recyclable list of items distributed to the residents.

The Contractor shall track repeat offenders, and report this activity to the community.

Commingling – The Collection Contractor shall not commingle any recyclable materials collected pursuant to this Agreement with any other material collected by the Collection Contractor.

Commercial Recyclables Collection – The Collection Contractor shall provide appropriate recycling containers for all recyclable materials collected to all commercial garbage customers, when they subscribe for service.

Collection Reports

The collection contractor shall report the following information to the community, on a Monthly, Quarterly or Annual basis, as deemed appropriate by the community.

Reports shall include detailed information on the following: Tonnage collected and delivered to the processing facility, reporting of promotional materials distributed.

Processing

Processor – The Collection Contractor shall deliver the collected recyclables to the community-designated Processor.

Processing – The Processor shall separate the commingled materials by type, such that the Processor can sell the materials for their highest and best use.

Contaminants – Processor shall remove contaminants from the recyclables.

Process Residue – The Processor shall remove recyclable materials from the residue before sending it off for disposal, or other use. The processor shall not dispose of more than incidental amounts of recyclable materials that are received from the Collection Contractor.

Incentives – Financial incentives will be provided if the contractor achieves the materials quality goals.

Penalties – Financial disincentives will be incurred if the contractor does not achieve the stated recyclable materials quality goals.

Processing Reports

The processing contractor shall report the following information to the community, on a Monthly, Quarterly or Annual basis, as deemed appropriate by the community.

Processor shall regularly report to the community and collection company the overall quality of materials received, and when there are contaminated loads, the processor shall report each occurrence. The report shall include the date, truck number, load weight, and nature of the contamination observed.

Reporting of volumes of materials processed.

Reporting of volumes of materials marketed.

The processing contractor shall report the following information to the community, on a Monthly, Quarterly or Annual basis, as deemed appropriate by the community. Reports shall include detailed information on the following: Tonnage received and processed at the processing facility; composition of the collected recyclables; tons recovered by commodity processed; tons marketed by commodity processed; the market and contact person for each material sold; amount of residue; composition of the residue; changes in processing that will (positively or negatively) effect the quality of the materials marketed, since the last reporting period.

Marketing

Paper – At a minimum, 75 percent of the newspaper collected shall be processed to meet the ISRI specifications for #8 news.

Of the remaining 25 percent of the newspaper collected, at least 80 percent must be recovered and marketed as mixed paper.

Not more than 2 percent of all collected paper shall be disposed as residue.

Container glass – At a minimum, 75 percent of the container glass collected shall be processed to meet the glass industry specifications for furnace ready cullet. This glass shall contain not more than 0.25 percent glass furnace prohibitives.

If the collected glass is shipped to a secondary processor before being shipped to a glass manufacturer, the secondary processor must meet these requirements.

Not more than 5 percent of all of the collected container glass shall be disposed as residue. The balance of the collected container glass may be used for other than high value added uses (such as road base or for landfill construction projects, to replace aggregate).

Aluminum – At a minimum, 98 percent of the aluminum cans collected shall be recovered and processed to be free of contaminants. Not more than 2 percent of all collected aluminum beverage containers shall be disposed as residue.

PET – At a minimum, 95 percent of the PET bottles collected shall be recovered and processed to be free of contaminants. Not more than 2 percent of all collected PET shall be disposed as residue.

HDPE – At a minimum, 95 percent of the HDPE bottles collected shall be recovered and processed to be free of contaminants. Not more than 2 percent of all collected HDPE shall be disposed as residue.

[Similar requirements should be placed on the marketing of other commodities collected by the community.]

Marketing Reports

The Contractor shall require that the buyers of each of the marketed commodities submit reports to the community on the quality of the materials received from the community program. The reports shall contain information on the contaminant levels in the loads received, and on any down-grades caused by insufficient quality of the materials.

Promotions

Program Promotion. The community shall be responsible for the preparation of all Promotional Materials relating to this Agreement. The Collection Contractor shall distribute the Promotional Materials as requested by the community. This shall include bill inserts, signage on the collection vehicles, and other materials as specified by the Collection Contractor in their Proposal to the community.

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