King County
Department of Natural Resources & Parks
Solid Waste Division

Waste Monitoring Program

Market Assessment for Recyclable Materials in King County

FINAL REPORT
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Introduction

1.1 MARKET ASSESSMENT GOALS

The King County Solid Waste Division commissioned Cascadia Consulting Group to conduct this study of markets for recyclable materials generated in the county. The goal of this research is to provide King County with answers to three central questions:

- What are the market conditions and dynamics for each targeted material?
- What is or will be the likely impact of these markets on local recycling programs?
- What can or should King County or the public sector in Puget Sound do to strengthen these markets?

The findings from this study and the recommendations presented in this report are intended to help inform and guide King County's decisions on recycling and solid waste management.

1.2 REPORT OUTLINE

This report presents key findings and recommendations from a study of markets for eight major recyclable material classes generated in King County. Following this introduction, two summary chapters look across these multiple materials to examine markets, assess needs and opportunities, and make recommendations.

- **Overview of King County Markets** (Chapter 2) provides an overall summary of King County markets for recyclables, including current and future supplies, value of recyclables, and key findings on market dynamics and trends.
- **Market Assessment Findings & Recommendations** (Chapter 3) examines, by specific material, the needs and opportunities for market development as well as the public sector's ability to influence the recycling marketplace. This chapter summarizes the key results of the market assessment and presents both overall and material-specific recommendations for King County action.

Following these two summary chapters, material-specific chapters focus on eight major classes of recyclables, listed below, which together comprise a majority of total waste generation in King County.

- **Electronics** (Chapter 4) – includes cathode ray tubes (CRTs), central processing units (CPUs) from computers, and peripherals;
- **Glass** (Chapter 5) – includes clear, brown, and green glass containers;
- **Metals** (Chapter 6) – includes aluminum cans and steel food cans;
- **Organics** (Chapter 7) – includes food waste, yard waste, and compostable paper;
- **Paper** (Chapter 8) – includes newspaper, cardboard/kraft (OCC), and mixed paper;
- **Plastics** (Chapter 9) – includes PET bottles, HDPE bottles, other plastic containers, and plastic film;
- **Textiles** (Chapter 10) – includes clothing, rags, curtains, and other fabrics; and
- **Wood** (Chapter 11) – includes recyclable urban wood, such as dimensional lumber, engineered wood, manufacturing scrap, pallets, crates, and other wood materials.

1.3 MATERIAL-SPECIFIC CHAPTERS

For each of the eight major material classes covered in this report, its chapter is divided into the following sections:

- **Introduction** – background on the material class, specific materials included, research methods, and an overview of the chapter;
- **Market Conditions**
  - **Trends & Key Variables Affecting Supply** – includes current and projected supply estimates;
  - **Processing & Infrastructure** – key processors and handlers of the recyclable material originating in King County;
  - **End Markets & Prices** – largely focused on markets for materials used as feedstocks for manufacturing, with less emphasis on markets for finished products;
- **Barriers & Opportunities** – obstacles that currently impede increased recycling of the material as well as potential areas for improvement;

- **Opportunities for Public Sector Action** – ways that King County or other public agencies can build on the opportunities identified in the previous section to achieve change; and
- **References** – works cited, interviews, and other sources of information used in the chapter.

1.4 STUDY METHODS

Cascadia Consulting Group collected a range of data on supply and demand conditions for the various material classes and specific materials. Our research included commodity prices, supply generation rates, capacity and throughput of end users, as well as previous studies related to recycling markets. Cascadia also conducted interviews with company leaders and other industry experts to obtain insights into market trends, needs, and opportunities for recycling of these materials.

The findings presented in this report are based on our interviews with recyclers, processors, and end markets; analysis of available supply data; King County projections of waste disposal; and a literature review. The findings provide the foundation for the analysis of market conditions, and they served as the basis for the subsequent stages of the study: 1) the assessment of barriers and opportunities; 2) the identification and ranking of opportunities for public sector action; and 3) the consultant recommendations for market development initiatives.

Each chapter's introduction includes a brief methods section noting the particular research strategy used for that material class, including interviews conducted and key sources referenced. For the overall assessment of materials, Chapter 3 provides an overview of the methodology, and Appendix A provides a more detailed description of the process as well as copies of the analytical spreadsheets produced during the assessment.

Chapter 2
Overview of King County Markets

This chapter provides a broad overview of markets for recyclables collected in King County. First, it reviews local waste generation, highlighting that more than half of the recyclable material remains in the waste stream disposed at the Cedar Hills Regional Landfill and elsewhere. King County is a major contributor to statewide recycling totals, which enables it to exercise some influence on markets, particularly for materials that have their end markets in the Northwest. The chapter next examines the value of King County's recyclables: per-ton prices, total value of recycled materials, and estimated value of potentially recoverable materials that remain in the garbage. Finally, the chapter concludes with a presentation of key findings on market dynamics and trends for recyclables generated in King County.

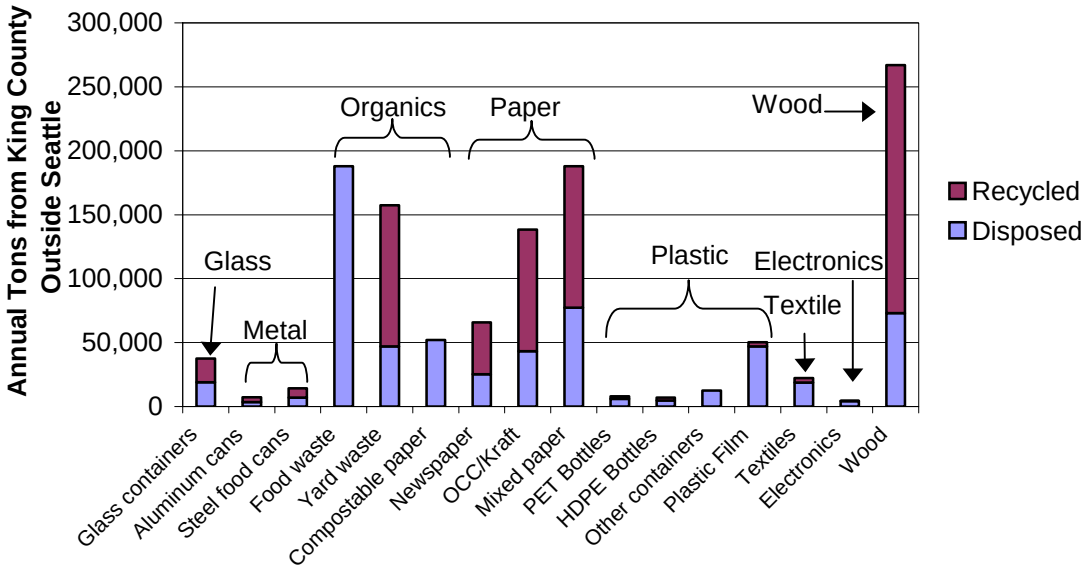
2.1 LOCAL SUPPLY OF RECYCLABLE MATERIAL

Recycling & Disposal in King County

As shown in Figure 2-1, King County outside Seattle generates more than 1 million tons each year of the eight major materials covered in this study: electronics, glass, metal, organics, paper, plastic, textiles, and wood. Of that total, nearly 600,000 tons are recycled, and slightly more than that amount is disposed, for an overall average recycling rate of about 48% for these materials. The recycling and disposal rates vary considerably across materials, with materials like wood, yard waste, paper, and metal showing relatively high recycling rates. In contrast, recycling rates are much lower for other materials, such as food waste, plastic, and electronics – indicating potential areas for improvement in collection systems and market development.

In addition to recycling rate, the magnitude of the waste stream is also an important factor in considering opportunities for market development. Comparing the "disposal" portion of the bars in Figure 2-1 indicates which materials represent significant opportunities for diverting remaining material from the waste stream and offer potential for providing additional supply of recyclable materials. Food waste represents the largest untapped supply, and wood and mixed paper also show large supplies remaining in the waste stream.

Figure 2-1. Recycling and Disposal of Major Materials Generated in King County, Tons per Year
(Excluding Seattle)



King County's Market Share

The amount of waste generation and materials collected within its boundaries make King County a major player in the regional recycling marketplace. For each of the eight material classes studied, King County (excluding Seattle) contributes between about one-quarter to more than one-third of the material collected in the state of Washington. In terms of recycling, King County shows above-average performance: the county represents about one-fifth of Washington's population and about one-quarter of the state's jobs, though it contributes about one-third of statewide recycling totals.

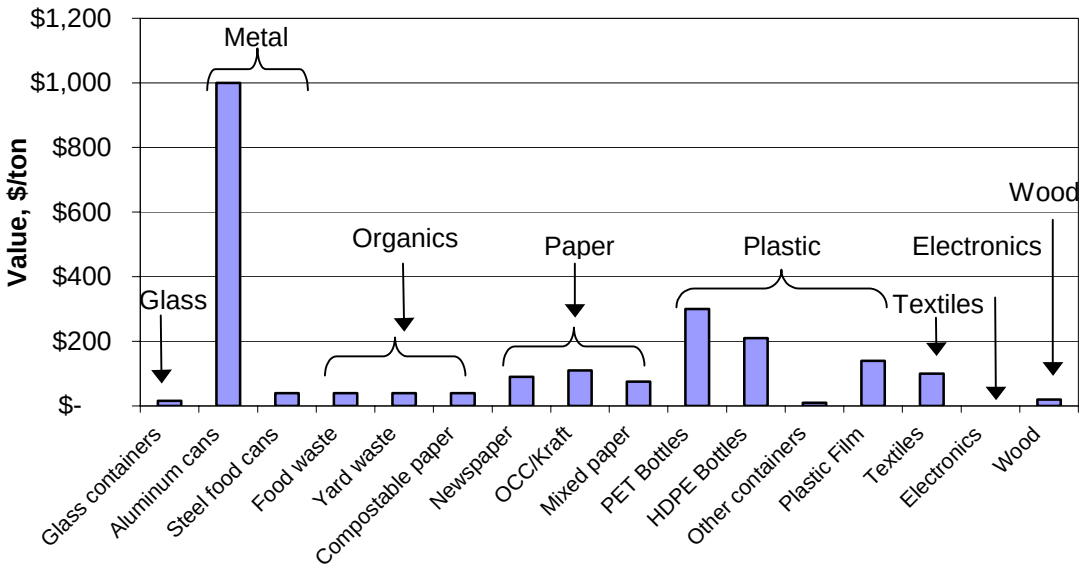
2.2 VALUE OF RECYCLABLE MATERIAL FROM KING COUNTY

Two main factors drive the overall value of recyclable material in King County's marketplace: the price obtained for the material collected and the amount of the material generated.

Per-ton Prices for Recycled Materials

Figure 2-2 shows the prices per ton of the major materials covered in this study. As shown, aluminum cans have by far the highest prices per ton, about $1000. With their high volume-to-weight ratios, plastic HDPE and PET bottles are the next highest, typically commanding prices of more than $200 per ton. Materials with the lowest (and sometimes negative) values in the current marketplace include glass containers, plastic containers other than PET or HDPE bottles, wood, and electronics.

Figure 2-2. Prices per Ton of Key Recyclable Materials, in King County

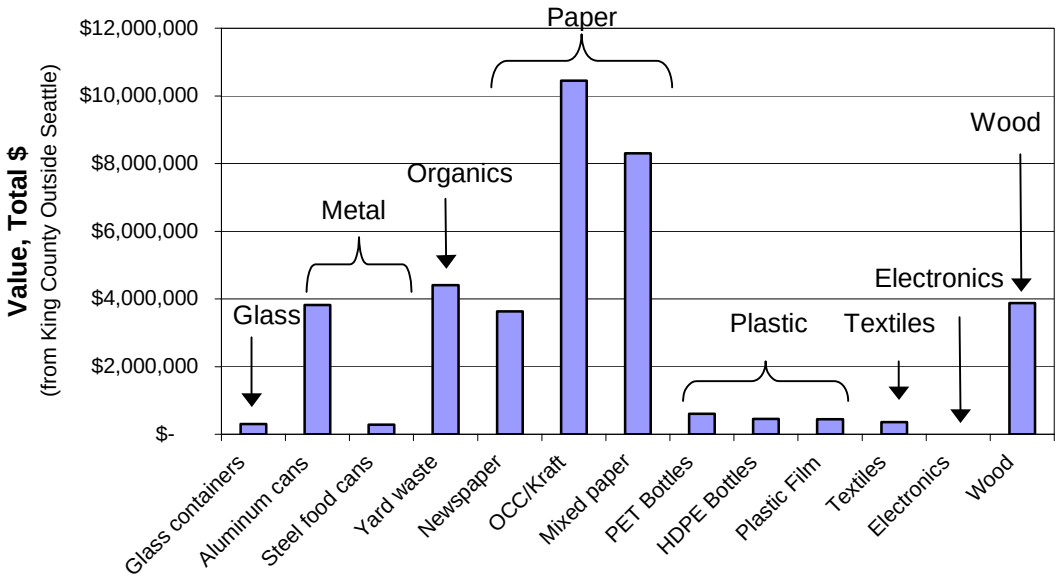


Note: Prices shown are current averages as of late 2003. For most materials, prices shown are what the primary processor (such as a MRF or other facility that sorts recyclables) receives from a materials reclaimer or broker (such as a pulp mill, plastics reclaimer, metals broker, or textiles broker). The only major exception to this method is organics, for which the price displayed is the approximate average price of finished compost. Also, please note that for materials (such as electronics) that are actually composites of other, separately marketed commodities, prices shown are approximate weighted averages of the prices for the individual commodities.

Total Market Value of King County Recycling

The amount of each material collected for recycling, coupled with its price, determines its total value in the marketplace. Overall, King County's recycling of the materials covered in this study had an approximate annual value of $37 million in 2003. In this analysis, materials with lower per-ton prices may have higher overall values, due to large quantities recycled. For example, as shown in Figure 2-3, OCC/kraft paper and mixed paper have the highest total value, followed by yard waste. Wood, aluminum cans, and newspaper also have relatively high total values. Glass, steel food cans, plastics, textiles, and electronics have much lower total values – as do food waste, compostable paper, and other plastic containers – materials for which no specific quantities were reported as collected for recycling.

Figure 2-3. Estimated Value of Key Materials Recycled in King County in 2003[1]



Potential Value of Discards

Examining the recyclable materials that remain in the disposed waste stream allows an estimation of the potential value that is thrown away instead of captured. The materials being thrown away instead of recycled have a real value, and their disposal represents a significant loss of resources. Applying the typical current prices to the annual tonnages thrown away yields a conservative estimate of more than $30 million worth of recyclables disposed at the Cedar Hills Landfill each year. This figure excludes plastic film, textiles, electronics, and

[1] Note that this figure excludes commodities for which no specific quantities were reported as collected for recycling, including food waste, compostable paper, and other plastic containers.

wood, some of which may not be marketable due to contamination or other factors. Including plastic film, textiles, and recyclable wood raises the total value to about $40 million. (Electronics are excluded from this estimate, as they typically have a value of zero or lower, mainly due to the high tip fees for lead-containing glass from cathode ray tubes in televisions and computer monitors. In the future, the economics of electronics recycling may improve as a result of product stewardship efforts and other changes in product composition, such as the shift away from cathode ray tubes.)

These lost dollars also have an opportunity cost in terms of unrealized job creation benefits. Based on estimates of jobs created per ton of materials recycled, the recyclable materials currently thrown away could likely generate 300 to 600 jobs if the resources were recovered for recycling.[2]

2.3 KEY FINDINGS ON MARKET TRENDS & DYNAMICS

Based on the analysis of current and expected future markets for recyclable materials collected in King County, this study reached the following conclusions regarding market trends and dynamics for the eight major material classes.

- **The markets for many materials are relatively mature and well developed.** Fortunately, recycling markets have largely emerged from a crisis mode, and many markets are established and stable. Accordingly, for many materials, market development efforts can be focused on value creation and maximizing the value of recovered resources, including increased diversion from the waste stream.
- **Certain materials require more basic market development assistance.** Recycling markets for materials such as electronics and food waste are in their early stages, as these materials are only beginning to be collected through public recycling programs. Accordingly, additional assistance may be needed as the addition of new materials to the recycling stream creates challenges for both the public and private sectors.
- **Some traditional recyclables need additional market attention.** Recycling rates have declined in recent years for some materials with a long history of successful recycling, such as glass and aluminum. Additional attention may be needed to enhance potential markets for these materials, maximize market value, and increase supplies diverted from the waste stream.

[2] These estimates are based on an assumption of 0.5 to 1 jobs per 1,000 tons of material recycled. These job creation figures are based on Cascadia's recent statewide survey of recycling and economic impacts: Cascadia Consulting Group, 2002, *Summary Report of the 2001 Survey of Washington State's Recycling* Industry, prepared by Cascadia Consulting Group, Inc., for the King County Solid Waste Division. These estimates are also consistent with data published by ILSR (Institute for Local Self-Reliance, 2002, "Recycling Means Business," http://www.ilsr.org/recycling/, viewed December 14, 2003).

- **Recycling markets are increasingly global in nature.** This drive towards increased globalization creates opportunities for selling King County's recyclable materials but also poses some challenges, particularly for local processors and end users.
  - **Exports are increasing, as Asian demand for recycled materials grows.** China and other parts of Asia show strong demand for some recycled commodities. Exports are currently accounting for a higher share of paper and plastic end market shipments than in the past, and higher paper grades and cardboard may be exported in the future. The global marketplace offers more markets for recyclables, and King County benefits from the region's close trading ties with Asia and favorable shipping rates for back-hauled containers.
  - **A trend towards less local processing is apparent, with potential economic and environmental consequences.** More materials are now being shipped out of the region, typically to Asia, in the form of mixed bales, particularly for plastics and paper. A reduction in local processing represents an economic loss to the region and also reduces King County's influence over how its recovered materials are processed and recycled. This shift may adversely affect the environment as well, if lower-value recyclables are landfilled overseas or inappropriately managed in nations with lower environmental standards.
- **Sorting of materials is increasingly automated.** Recycling facilities in the region are handling more material and using fewer employees on their sort lines. The latest material recovery facilities (MRFs) are capable of sorting more than 600 tons of recyclables per day, using trommels and other technology, with fewer sorting crew members. Despite higher capital costs, automated methods are becoming widely used, including advanced sorters that can separate glass and paper by color and grade. Quality control, plastic sorting, and overall management, still require significant staff resources at MRFs, however.

Curbside Collection of Recyclables

This report uses the following terms to describe different types of collection systems for recyclables. (In all of these systems, recyclables are collected separately from garbage; any yard waste or other organics recycling also occurs separately.)

Source-separated recycling – A multi-bin system in which participants sort each type of recyclable (e.g., glass, paper, metal) into its own container for recycling.

Commingled recycling – A system in which most recyclable materials (e.g., paper, metal, plastic) are recycled together in a single large container, while glass is often collected separately to reduce breakage. Many parts of King County currently use such a system.

Single-stream recycling – A type of *commingled recycling* in which all recyclables including glass (but not organics) are collected in a single container. Some haulers are currently promoting this method as a way to reduce collection costs and simplify recycling for participants.

- **Waste haulers continue to favor increased commingled collection of recyclables, and source separation is declining.** For example, Waste Management and Allied are currently promoting single-stream recycling – the commingled collection of all curbside recyclables, including glass. Commingled collection can reduce the quality of recycled materials if processing cannot remove contaminants. As a result, end markets may need to adjust their feedstocks, processes, or products to adapt to changes in the recycled waste stream.
- **Quality of recycled materials remains a concern, particularly with the trend towards single-stream collection.** Anecdotal reports indicate that quality of recovered materials has declined as communities have switched to commingled collection of recyclables, including single-stream recycling. Single-stream programs, coupled with typical processing methods, appear to be contributing to contamination problems, potentially affecting markets for glass, plastics, and paper. Currently, the healthy demand for recovered materials makes markets less sensitive to quality issues, but this situation could change in the future. King County's markets for its recyclables will remain more stable if the region can maintain higher quality levels than other suppliers in the marketplace. Even for materials that are not traded in a global marketplace, such as organics, quality can be an important issue. Though quality appears to have improved, our research revealed some remaining concerns among end users about the presence of weed seeds in compost and the variability of compost, particularly in terms of moisture content and particle size.
- **Valuable recyclables continue to be lost to disposal, representing real costs in dollars, jobs, and resources.** Inefficient and/or incomplete systems for collection and processing of recyclables leave more than half of the potentially recoverable material in the disposal stream, representing more than $30 million in lost value and hundreds of jobs.
- **Strong market demand could readily handle additional recycled materials for some commodities.** In particular, more supply is needed for PET plastic bottles, aluminum cans, and various types of paper. This situation represents an important opportunity for public sector action, as government policies have often proven more effective at increasing supplies than stimulating demand.
- **Most current markets are strong, but they remain cyclical in nature.** Though current prices are high for many materials, these favorable rates are unlikely to remain the norm in the future. Some analysts have recently predicted an impending slump in the Chinese economy, resulting in declines in commodity markets and prices for recycled materials.

Chapter 3
Market Assessment Findings & Recommendations

3.1 ASSESSMENT OF MARKET NEEDS & OPPORTUNITIES

The market research conducted for this study revealed varying levels of needs and opportunities associated with the targeted materials. Those needs and opportunities also differ in their significance, however, as does the potential for King County to affect these market dynamics through its actions. This chapter evaluates and ranks the relative market development needs, opportunities, and King County's ability to influence markets for each of the targeted materials. The goal is to provide guidance on areas where public sector action could address key market development needs as well as other areas where King County initiatives would likely yield fewer benefits, due to lower levels of need, opportunity, or influence.

Approach & Criteria

Our approach to this evaluation closely follows the methodology developed for the previous market assessment study conducted for King County in 1998. The following section summarizes the key methods that the study used.

First, we developed ranking criteria associated with the three primary drivers for public-sector market development programs and policies:

- **Need for Market Development:** What problems, if any, exist with the supply, demand, or supply chain infrastructure? Also, what economic and/or environmental threats are associated with disposing and recycling each of the materials?
- **Opportunity for Market Development:** What is the potential to increase demand, provide additional supply, or improve the functioning of the market, considering all stages in the supply chain?
- **Ability to Influence Market Development:** To what degree can King County, acting on its own, through partnerships with other governments, or through such avenues as product stewardship, affect the markets or supply chain for the targeted material?

In our assessment, each of these three drivers included five to six specific criteria and associated key questions, as outlined in Table 3-1 for **Need**, Table 3-2 for **Opportunity**, and Table 3-3 for **Ability to Influence**. These tables provide more detail on each of the drivers and include the criteria that the consultant team used in the market assessment process.

The evaluative criteria used in the current study are generally comparable to those used in the previous 1998 study, though several additional criteria were added or revised. In particular, the current study considered sustainable

development – the integration of environmental, economic, and community factors – as an element of the market assessment. Since most of the previous criteria focused on economic factors, placing the assessment in a sustainability context entailed adding environmental and community development as important elements of a strategy for supporting recycling markets. The environmental factors included an assessment of the current environmental harm and environmental potential (prospective benefits) associated with particular materials. The community element considered recycling markets on a local and regional level, covering such elements as the potential for job growth, economic development, and value-added end markets in the region associated with certain materials.

Table 3-1. Market Assessment Criteria – Need for Market Development

Criteria	Key Questions
Market Sustainability*	How stable and diverse are markets for this commodity? Do long- term trends support this stability and diversity?
Volatility*	Are prices, supply, and/or demand volatile or unpredictable? Is there a significant imbalance between supply and demand in the marketplace?
Magnitude	How many tons are currently disposed? Do these tons represent a significant share of King County's disposal stream?
Local Economic Stability	Are local/regional recycling markets, companies, or jobs threatened or likely to be at risk?
Environmental Harm	To what degree would increased recycling through improved markets reduce or prevent environmental degradation at the point at which the product reaches the end of its useful life?
Quality*	Are material quality levels sufficient to sustain the market over the long term and to maximize revenues in both the short and long term? Or are quality issues a significant concern potentially undermining market viability?

** Asterisks indicate criteria that were weighted more heavily in the assessment process.*

Table 3-2. Market Assessment Criteria – Opportunity for Market Development

Criteria	Key Questions
Demand Potential*	Can markets absorb more material? Is there unmet or latent demand in intermediate or end markets?
Supply Potential*	How much recyclable material is being disposed, in terms of absolute tons and as measured by the material specific recycling rate? A low recycling rate for a recyclable commodity translates into a high supply potential; conversely a high recycling rate or few tons in the disposed waste stream translates into a lower supply potential.
Technology Potential	Are new technologies available or under development that would spur market development?
Environmental Potential	To what degree would increased recycling promote environmental gains, with a specific focus on upstream and lifecycle benefits?
Value-added Potential	To what extent could additional value be added in processing and production? Is downcycling currently occurring, to a significant or lesser degree? What is the value-creation opportunity for potential increases in material diverted from the waste stream?
Local Economic Potential	What is the potential for job creation and increased economic activity in the region? What is the potential for value-added end market development in the region?

** Asterisks indicate criteria that were weighted more heavily in the assessment process.*

Table 3-3. Market Assessment Criteria – Ability to Influence Market Development

Criteria	Key Questions
Local Markets	To what extent are demand and prices determined by local markets versus tied to global markets?
Regulatory Factors	What regulatory or other power does King County have to affect markets? Does exercising this regulatory power address the market needs and/or opportunities identified in the market research?
Market Share	What share of supply and demand at each stage of the recycling loop is in King County and/or the greater Puget Sound region?
Maturity	To what degree are markets at each stage of the recycling loop already fully developed or mature? Is there sufficient supply and demand at each stage such that a significant percentage of generated material is recycled on a consistent basis over time?
Leverage*	To what extent can King County influence the supply chain and markets through pilot projects, use of purchasing power, specialized market assistance, product stewardship initiatives, or other actions? How much can King County influence the key barriers and opportunities affecting markets for specific recyclable materials?

** Asterisks indicate criteria that were weighted more heavily in the assessment process.*

Second, we reviewed the criteria to determine which, if any, are more important than the others within each category. These criteria were then weighted more heavily than the others, as noted below.

- In the *Need for Market Development* category, the following criteria were weighted more heavily: **market sustainability**, **volatility**, and **quality**.
- For *Opportunity for Market Development*, **supply potential** and **demand potential** were both considered more important than the other criteria in that category.
- For *Ability to Influence*, the **leverage** criteria received was weighted more heavily relative to the other factors.

Third, we rated materials qualitatively against the criteria using a scale of 1 to 5, with 5 equaling the highest possible rating – equivalent to the highest need for, opportunity for, or ability to influence market development. Key members of the consultant team contributed to this rating process with particular emphasis given to input from the lead team member responsible for evaluating market conditions for each specific commodity. We developed and used a spreadsheet model for this process. After each team member scored each material against the criteria, team members met to discuss ratings and review scores to reach consensus ratings and ensure consistency across materials and reviewers.

Market Assessment Results

For each material covered in the study, this section presents the results of the evaluation process, including tables and graphs. It provides information that King County can use to help establish priorities for its market development programs and related policy actions.

Highest Need for Market Development

Using the assessment methodology described above, we rated each specific material according to its need for market development efforts. The assessment of need considered market sustainability and volatility, magnitude, local economic stability, environmental harm, and material quality.

Table 3-4 shows the recyclable materials ranked with the highest need for market development. The specific materials with the highest needs are all in the organics, electronics, plastics, or glass material classes. Following the table, the section discusses each of the materials included on the highest need list. Additional information on the ratings and detailed material-specific results appear in Appendix A.

Table 3-4. Materials with Highest Need for Market Development

	Specific Material	Material Class	Need
1	Food waste compost	Organics	4.0
2	CRTs (TVs & monitors)	Electronics	3.9
3	#2 non-bottle containers	Plastics	3.9
4	E-waste plastics	Electronics	3.8
5	#3-7 plastics	Plastics	3.8
6	Leaded glass	Electronics	3.6
7	Glass fines	Glass	3.5
8	LCDs	Electronics	3.3
9	Computer peripherals	Electronics	3.3
10	Sorted glass: GREEN	Glass	3.2

Ten recyclable materials were classified as having the **highest need** for market development, with the rationale as follows:

- **Food waste compost** tops this list primarily because markets for this material are only beginning to be developed; quality issues need to be addressed; and large quantities of food waste are present in the waste stream.
- **Markets for cathode ray tube (CRT) computer monitors and TVs** are problematic and highly limited, with a high level of dependence on the dwindling glass-to-glass market. If new CRT manufacturing shifts entirely overseas – as is expected within this decade – the dominant market for CRTs and **leaded glass** will either go with it or disappear completely. At present, the only alternative market is lead smelters, which have limited capacity. New markets or approaches are clearly needed.
- Markets are also needed for **#2 non-bottle plastic containers**. This plastic is increasingly being collected from the King County waste stream, and the materials are highly recyclable. A reliable supply chain for this type of plastic has yet to be developed, however, and some of this material may be disposed. These conditions also apply to **#3-7 plastics bottles and containers**.
- Markets for **e-waste plastics** are also extremely limited. Market development is needed in this area to keep much of the material recovered from electronics recycling programs from being disposed. Half of the materials rated on high need list are associated with electronics recycling, including **CRTs**, **leaded glass**, **liquid crystal display (LCD) monitors**, and **computer peripherals**, in addition to e-waste plastics. These high ratings point to the relative instability and volatility of the supply chain for recycled electronics, which is only now being developed and depends in part on exports and uncertain environmental and human health practices.

- Rounding out the high need list are **glass fines** and **green glass**. Markets for these glass materials are highly limited in the region, and much of the material is currently being stockpiled in the absence of end markets.

Highest Opportunity for Market Development

Table 3-5 summarizes the specific materials that ranked highest in terms of opportunity for market development or potential for enhancing markets. The assessment of opportunity considered demand and supply potential as well as the technology, environmental, value-added, and local economic development potential.

The specific materials with the highest market potential are in the plastics, wood, organics, electronics, and metals material classes. Following the table, the section discusses each of the materials included on the highest opportunity list. Additional information on the ratings and detailed material-specific results appear in Appendix A.

Table 3-5. Materials with Highest Opportunity for Market Development

	Specific Material	Material Class	Opportunity
1	Plastic film	Plastics	4.0
2	Urban wood	Wood	3.9
3	Food waste compost	Organics	3.9
4	Yard waste compost	Organics	3.9
5	CPUs	Electronics	3.6
6	Circuit boards/precious metals	Electronics	3.5
7	Aluminum cans	Metals	3.5
8	#1 PET bottles	Plastics	3.5
9	#2 HDPE bottles: NATURAL	Plastics	3.5

The assessment rated nine recyclable materials as having the **highest opportunity** for market development, with the following rationale:

- **Plastic film** and **urban wood** scored at the top of the opportunity scale, primarily due to high demand for these materials in the marketplace. Markets for plastic film are increasingly strong and diversified, with significant demand from Northwest, West Coast, and Asian buyers. Local and regional demand for urban wood for hog fuel is also high. Furthermore, Boise Building Solutions' efforts to develop a home siding product using recycled plastic film and urban wood offers the possibility of a large, stable, local, and high-value market for both these materials if the company can resolve its current technical issues.
- **Food waste compost** and **yard waste compost** also scored highly on the opportunity scale. Food waste compost scored high on all the opportunity criteria, with a high level of potential demand, supply, and opportunity for value creation, since most food waste is currently

disposed. Market opportunities are also strong for yard waste compost, with significant potential demand, supply (significant quantities of yard waste are still being disposed), and the emergence of the new Gore Cover technology to lower compost processing costs, time, and environmental impacts.

- Among electronics, **CPUs** and **computer circuit boards, including precious metals**, present high opportunities for market development. Computer circuit boards are generally the most valuable material (per pound) found in e-waste, due to their precious metal content. Selling them to refiners or precious metal smelters provides a revenue stream for e-waste recyclers and helps offset environmental harm associated with virgin production of precious metals. Because so many CPUs and other electronic equipment containing circuit boards are presently stockpiled, King County and local recyclers have the opportunity to "mine" this e-waste stream for economic and environmental gains.
- Several traditional recyclables are also considered high opportunity areas, including **aluminum cans**, **#1 PET bottles**, and #**2 HDPE natural bottles**. These commodities are on the list primarily because of the high level of demand relative to available supply. Strong markets exist for these materials, meaning that any additional supply generated through King County programs or policies would find ready markets and would help feed the robust supply chains that exist for these materials.

Highest Ability to Influence

King County's ability to influence the market for recycled materials is determined in large part by the geographic scale of those markets. In most instances, markets that are local or regional in nature are more susceptible to County influence than those that are global. In addition, King County has the ability to influence both supply – by providing and/or requiring curbside collection – and demand – primarily by serving as an end market for the recovered material.

Using the assessment methodology described earlier in this chapter, we rated each specific material according to the public sector's ability to influence market development. The assessment of ability to influence considered local markets, regulatory factors, market share, maturity, and leverage. Additional information on the ratings and detailed material-specific results appear in Appendix A.

Of the materials that rated as high needs or high opportunities in the preceding sections, not all of them are easily influenced. For example, PET bottles rated relatively high in opportunity – mainly due to their high market value but low recycling rates – but lower in King County's ability to influence the marketplace, largely because the market is strongly international and experience elsewhere shows the difficulty of implementing policies that effectively increase supply.

Therefore, King County should consider its ability to influence as a criterion in selecting high-priority materials. By using *Ability to Influence* as a lens through which high-need and high-opportunity materials can be assessed, King County

can select priority materials where action will have a high probability of success. That is, ability to influence should not be considered in a vacuum; the public sector should exercise its influence only in areas with needs, opportunities, or both.

Accordingly, this section examines ability to influence in relation to needs and opportunities and presents the results in the following figures. Figure 3-1 displays the Need rating for each material relative to the County's ability to influence it, and Figure 3-2 displays the Opportunity rating for each material relative to the County's ability to influence it. Materials that rate particularly high in both ability to influence and either need or opportunity will plot in the upper right quadrant of the respective charts. Such materials appear above and to the right of the upper, right-hand curve. These materials are considered high-priority items and thus are prime candidates for County action. In the band between the two curves on each chart, the medium-priority materials appear. The low-priority materials appear in the lower-left portion of the chart, below the lower curve. These items ranked lower on need or opportunity, ability to influence, or both.

Figure 3-1. Ability of King County to Address Market Development Needs

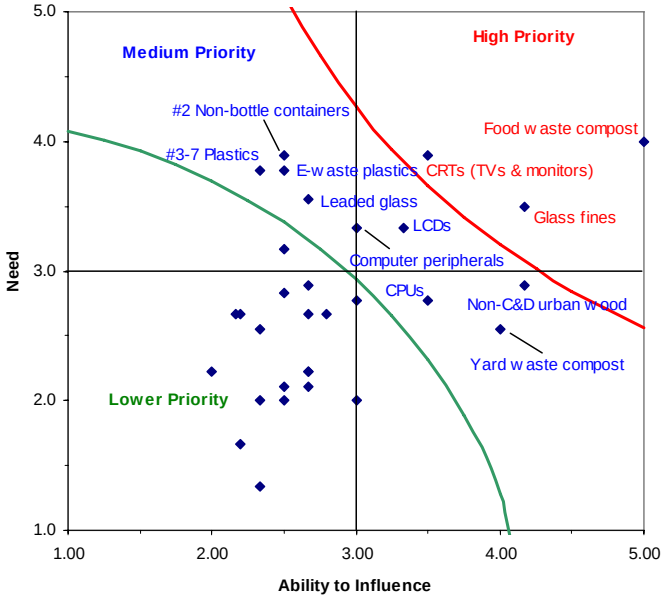
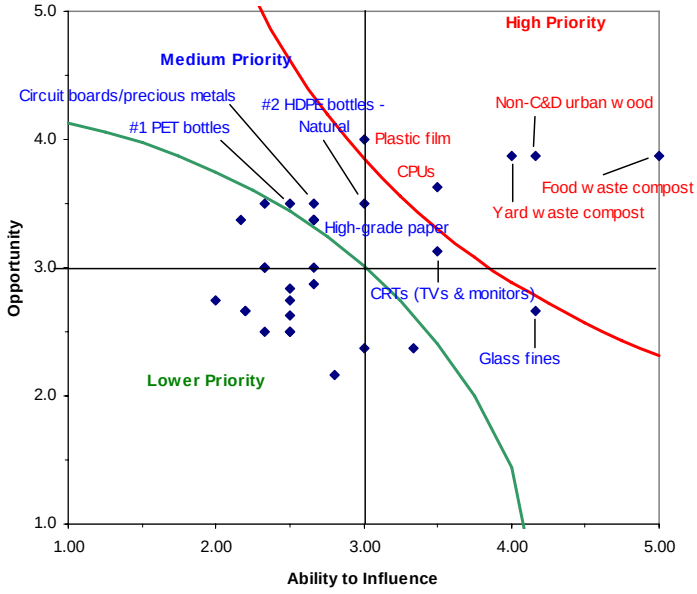


Figure 3-2. Ability of King County to Address Market Development Opportunities



		Material	Composite Need and Ability Rating
High Priority	1	Food waste compost	4.5
	2	Glass fines	3.8
	3	CRTs (TVs & monitors)	3.7
Medium Priority	4	Urban wood	3.5
	5	LCDs	3.3
	6	Yard waste compost	3.2
	7	Computer peripherals	3.2
	8	CPUs	3.1
	9	#2 non-bottle containers	3.1
	10	Leaded glass	3.1
	11	E-waste plastics	3.1
	12	#3-7 plastics	3.0

		Material	Composite Opportunity and Ability Rating
High Priority	1	Food waste compost	4.4
	2	Urban wood	4.0
	3	Yard waste compost	3.9
	4	CPUs	3.6
	5	Plastic film	3.5
Medium Priority	6	Glass fines	3.3
	7	CRTs (TVs & monitors)	3.3
	8	#2 HDPE bottles: NATURAL	3.2
	9	Circuit boards/precious metals	3.1
	10	High-grade paper	3.0
	11	Cardboard (OCC)	3.0
	12	Newsprint (ONP)	3.0
	13	#1 PET bottles	3.0

Note: Composite ratings were developed using the concept of a geometric mean, which like the arithmetic mean, is a type of average. In this analysis, we produced the composite ratings based on the geometric mean of the two respective variables: Ability to Influence and either Opportunity or Need. One practical advantage of the geometric mean is that it tends to lower the ranking of materials where one of the criteria is rated particularly low (even if the other is higher) in favor of materials that have a strong balance. In this case, such an algorithm is desirable because it will tend to deemphasize materials which have either an extremely low Ability to Influence or Need/Opportunity, as it would be difficult to make a strong case for action for such materials.

Market Assessment Summary Results

Based on the assessment of Need, Opportunity, and Ability to Influence, our study identified seven high-priority materials for market development efforts:

- **Food waste compost**
- **Plastic film**
- **Glass fines**
- **Yard waste compost**
- **Urban wood**
- **Cathode Ray Tubes (CRTs) – TVs and computer monitors**
- **Computer Central Processing Units (CPUs)**

Following the overall recommendations in the following section, the remainder of this chapter presents key findings and material-specific recommendations for these top-ranked materials as well as other selected materials.

3.2 OVERALL RECOMMENDATIONS

The research conducted for this study, combined with the identification of key trends, and the assessment of needs, opportunities, and influence provide the basis for a set of recommendations for potential market development initiatives. The following section presents a set of overall recommendations to guide market development efforts for various recyclable materials in King County. Section 3.3, beginning on page 26, provides summary findings and recommendations for high-priority and selected other materials: food waste compost, plastic film, glass fines, yard waste compost, urban wood, electronics, and other high-value materials.

Six recommendations are offered for King County consideration related to overall market development priorities and strategies. The County may not be able to implement all of these recommendations on its own, and cooperation with other levels of government as well as key stakeholders may increase the chances of success.

1. Focus market development resources and activities on high-priority materials.

The following list shows materials that have a relatively high need and/or opportunity and where King County has some leverage to influence the market place. The list also notes whether need, opportunity, or both is the strongest factor influencing the high ranking. Top materials currently are as follows:

- **Food waste compost** (need and opportunity)
- **Plastic film** (opportunity)

- **Glass fines** (need)
- **Yard waste compost** (opportunity)
- **Urban wood** (opportunity)
- **CRTs** (need)
- **CPUs** (opportunity)

2. Consider and apply the full range of policy and program options to achieve market development objectives.

Over the past several years, King County has become adept at pursuing different strategies to achieve its goals related to waste reduction and recycling. This diversified approach applies to market development as well. The key is to pursue the right strategy maximizing leverage and impact to either address an important market development need or realize the value inherent in an opportunity.

Key options to consider include the following:

- **Bans and/or mandates** – These strategies are particularly appropriate when the need or opportunity is related to a lack of supply of recovered material.
- **Product stewardship** – When market development needs are systemic and private sector initiatives are needed, product stewardship can be a viable strategy. In a product stewardship approach, the designers, manufacturers, retailers, users, and disposers of a product take responsibility for minimizing its environmental impact at all stages in its lifecycle. Such stewardship includes transformative actions such as creating initial end markets or redesigning products. Product stewardship strategies are already being applied to electronics recovery systems and could easily be extended to other aspects of market development for this class of materials. One note of caution, however, is that the efficacy of the product stewardship approach has yet to be fully proven, as the private sector is only reluctantly participating in many of these processes to date. Nonetheless, this approach offers the potential for leveraging County resources to much greater effect than would be possible acting alone.
- **Purchasing power** – King County's purchasing power can also be transformative in creating and even sustaining market demand. Using purchasing power for materials that primarily have local markets, such as compost, can be an especially effective use of public sector resources.
- **Partnerships** – In many instances, the County's ability to influence market conditions for high volume global commodities is quite limited. In these instances, partnerships with other government entities at the regional, state, or national level can provide the leverage essential to address a given market need and/or opportunity. Partnerships with

private sector entities should also be considered where interests align related to strengthening markets.

- **Technical assistance** – The LinkUp program has been highly effective in establishing niche end market demand and processing capacity for recyclable materials sourced both from the County and elsewhere. The LinkUp program's influence extends beyond the region to other states, providing important leverage to achieve market development success. Focusing LinkUp and other technical assistance resources on the "weak link" in the supply chain for each material is one way to maximize the return for the County's investment in this program area.
- **Education and promotion** – Our research revealed the continued importance of nurturing end use demand for recycled commodities and recycled content products. Building awareness and then changing behavior among consumers and businesses through marketing and education campaigns has proven to be an effective means of achieving market transformation. Such campaigns should be used strategically to support specific market development objectives for targeted materials.

3. Pursue and adapt strategies that address market needs and opportunities in good and bad times.

Current markets for many materials are quite strong, principally fueled by the booming Chinese economy. In such markets, issues such as material quality and diversification are often ignored. Markets are cyclical, however, and economists are forecasting a slowdown in Chinese commodity demand. Initiatives by King County to ensure that commodities recovered from this region are well positioned for weak markets will help avoid future problems and crises. Such efforts could include safeguarding the quality of local recyclables through public education and hauler oversight as well as supporting a diverse base of local recycling processors and end users through programs like LinkUp.

4. Address supply-side needs and opportunities, not just demand-side conditions.

Traditional public sector market development programs have focused almost exclusively on the demand side of the equation – finding ways to influence or create end markets for recyclables collected from curbside programs. This focus made sense early in the development of the recycling industry, when a lack of demand caused supply-demand imbalances and threatened to undermine nascent municipal sponsored recycling efforts.

Today, however, the situation is far more complex and nuanced, with needs and opportunities on both the demand and supply side of the ledger. Public sector market development actions, therefore, should include action where more supply is needed at a reasonable cost as well as where demand growth is essential or intermediate processing facilities are needed. For example, the recycling rate for

aluminum cans hovers around 50%, meaning that substantial quantities of valuable material are wasted. Yet every additional pound of aluminum collected can and will be recycled, at great benefit to recyclers, end users, and the environment. Market development actions by King County and other public agencies to increase the supply of aluminum are therefore warranted and potentially significant to the value-added benefits of recycling to our regional and national economy.

5. Focus on improving material quality, and manage the impact of commingled and single-stream collection on quality and markets.

Our research revealed that quality concerns continue to threaten the viability of recycling markets for a host of materials from glass, to paper, to compost. Ensuring that high-quality recyclables are sourced from King County is important for several reasons. First, higher quality translates into higher prices paid for the material and greater value-added benefits for the region. Second, higher quality supply allows King County recyclers to compete effectively with other sources when markets are weak. Delivering quality is, in part, an insurance mechanism to allow the region to weather downturns and slumps in demand. Third, maintaining a high quality standard throughout the collection and processing phases builds support for recycling among the public. The consequence should be more material with less contamination sourced from curbside programs and businesses.

Stakeholders have expressed concern that quality of recyclables shipped from material recovery facilities (MRFs) located in the county has declined over the years as a result of shifts to commingled collection systems, including single-stream recycling, and streamlining of MRF operations. It is recommended that King County monitor this situation and consider establishing standards or benchmarks for recycling service providers and MRF operators to achieve. King County could work with local governments to incorporate these standards into waste management contracts or mandate them through a service level ordinance. The needed next step is for King County to decide that quality is a core element of its solid waste management program. Subsequently, general strategies as well as those tailored to the needs for each material can be developed and implemented to achieve desired quality standards.

6. Maximize the regional value-added benefits of recycling.

In this era of globalization, more materials are being shipped overseas and less and less value-added processing and manufacturing is occurring regionally or even domestically. There are many benefits of globalization related to recycling but there are also potential costs and negative consequences. It is recommended that King County consider local and regional economic development potential and impacts in setting solid waste policies and implementing programs related to market development. The goal should be to maximize value-added benefits associated with recycling programs, including a

consideration of job creation and retention as well as the viability of regional facilities such as paper mills that have traditionally processed material sourced from King County.

3.3 FINDINGS & RECOMMENDATIONS FOR KEY MATERIALS

Key findings and recommendations for high-priority and selected other materials are presented below. The highest ranked materials are considered first; then electronics are discussed as a group; and finally possible actions for other high-value materials are considered. As with the overall recommendations, King County alone may not be able to implement all of these recommendations, and cooperation with other levels of government and key stakeholders may increase the likelihood of success.

Food Waste Compost

Situation

Recovery and processing of food waste, as well as marketing the finished compost or other organic product, are in early stages in the region, though recovery is growing rapidly. Following a King County pilot project, Kirkland, Redmond, and Bellevue are now offering residential curbside collection of food waste and yard waste. Both the need (to establish the supply chain for this valuable material) and the opportunity (to provide a nutrient-rich organic product to regional horticultural end users) are rated high in our assessment, making this material ripe for public sector action. The key needs to establish a viable supply chain and market for this material include:

- Expand food waste recovery beyond the existing programs to provide the critical mass of countywide supply needed to justify local processing investments and development of end markets.
- Address the economic disincentive to food waste recovery inherent in the pricing of garbage collection services.[3] Instituting a pricing system in which disposers of food waste pay the actual costs of its disposal, based on weight, would create incentives for reducing their food waste disposal through alternative methods such as composting.
- Foster economically viable systems, such as appropriate transfer facilities, to consolidate food waste and transport it to processing sites.

[3] Currently, many customers pay based on the volume of their disposal, rather than its weight. In contrast, haulers pay tip fees based on weight, not volume. Because food waste is heavy, volume-based pricing may not cover the actual weight-based costs of disposal, and food waste disposal in effect receives a subsidy from other materials. Accordingly, the benefits of reducing food waste disposal in garbage accrue mainly to haulers rather than to those paying for disposal. Even with lower per-ton tip fees for compost than garbage, food waste disposers may not realize savings through composting due to the switch from volume-based pricing (which effectively subsidizes food disposal) to weight-based pricing at compost facilities. Thus, restaurants and other food waste disposers lack strong economic incentives to reduce the amount of food waste in their trash. King County alone could not alter such pricing systems unilaterally, and the Washington Utilities and Transportation Commission would need to approve such changes.

- Ensure that new processing technologies, such as the Gore Cover system, perform according to design, mitigating against odor, and that other environmental safeguards are followed during processing.
- Ensure that finished products meet quality standards and gain acceptance in the marketplace.
- Educate end users about the benefits of food waste compost products, thereby building demand.
- Address the potential for a monopoly on food waste processing in the region and the possibility for adverse economic or market consequences associated with monopoly power.

Recommendations

- Continue to facilitate implementation of pilot and permanent food waste collection programs for residential and commercial customers.
- Define and evaluate options for a least-cost collection, handling, transfer, and transportation system for food waste collected from commercial sources.
- Assess commercial solid waste rate structures and identify opportunities to influence rates or introduce other financial incentives to encourage the diversion of food waste from disposal, including tip fee surcharges, if applicable.
- Collaborate with haulers to ensure that processors receive material with adequate quality and minimal contamination.
- Consider partnering with the Department of Ecology or the Washington Organic Recycling Council to require an independent certification or labeling for all compost sold in the state.
- Educate consumers and end users, once an adequate supply of compost made from food waste is available in the marketplace. Combine efforts with existing campaigns related to Soils for Salmon, water quality, and yard waste composting.

Plastic Film

Situation

Markets for plastic film are strong and growing. Many new reclaimers have entered the plastic film market in the last several years, making the marketplace increasingly diversified and competitive. Historically, recycled plastic film has been used primarily to produce plastic lumber products. Trex has been the leader in this field, but the company has been experiencing growing competition from a number of companies. Most notable in the Puget Sound region has been Boise Building Solutions, a company that has been working to develop and market a composite wood/plastic siding product. Recently, however, Boise has ceased purchasing film due to technical difficulties with production. Several

years ago, this development could have had a serious negative impact on film recycling in the region, but demand and prices in the marketplace have shown few effects, likely due to the increased diversity of the plastic film marketplace.

The private sector is aggressively sourcing plastic film from commercial sources in the Puget Sound region, as well as elsewhere. An estimated 3,200 tons were recovered in 2002. According to King County's 2002-2003 waste stream composition study, 47,000 tons are still disposed, though not all of those materials are recyclable. Additional research may be needed to obtain current figures, however, as the private sector continues its intense pursuit of plastic film, particularly for use in the manufacture of plastic/wood composite products.

Recommendations

End users need more clean uncontaminated plastic film at a price that allows them to produce a finished product that can compete with virgin alternatives. Currently end users are paying between $0.05 and $0.08 per pound for baled, mixed-color plastic film. Successful efforts to increase the supply of plastic film diverted from disposal rely on accurate assessments of how much plastic film remains in the waste stream and identification of key generators. Accordingly, a first step for King County is to obtain current data on the plastic film remaining in the waste stream to ensure that it should remain a high-priority material. Possible actions for King County to stimulate additional supply include:

- As resources and site improvements allow, provide facilities and incentives for plastic film recycling at King County transfer stations and encourage plastic film recycling at private transfer facilities. Programs in California may provide useful models.
- Implement a promotion campaign, potentially in partnership with the private sector, to build awareness among commercial generators of plastic film recycling opportunities.
- Promote plastic bag take-back programs, in which residents return their used grocery sacks and merchandise bags to their nearby grocery or drug store for recycling

More aggressive actions such as bans and curbside collection are not recommended at this time because of the need by end users for quality feedstock material. Current experience with curbside programs in Seattle and Tacoma suggest that it is difficult to meet quality standards for plastic film. Likewise bans would likely produce large quantities of contaminated material that may not be acceptable to current end users.

Glass Fines

Situation

Most recycling programs collect multiple colors of glass in one container. Glass processors then use optical sorting devices to sort clear (flint), brown (amber), and green glass for sale to end markets. However, approximately one-quarter of

the glass is too small to be effectively sorted by this equipment, and it may be contaminated by a variety of other materials. These glass fines (as well as surplus color-separated glass that cannot be sold to end markets) are generally either stockpiled or moved (sometimes for a fee) into fill or other construction applications. Currently, construction markets for glass are down, resulting in large quantities of glass being stockpiled: there is therefore a need to create a stable, long-term market for glass fines. Additional work may be needed to reduce contamination, especially given the increasing trend towards single-stream recycling. King County has the ability to influence glass fine recycling through market development assistance and possibly through direct purchasing of the glass for infrastructure projects.

Recommendations

Construction markets are a natural fit for glass fines, but the construction industry's continued use of its standard operating practices has reportedly made it difficult for glass fines to gain much market share. Furthermore, the construction industry is not likely to be a high-value market for glass fines, so additional work may be necessary to find higher-value uses. Possible actions for King County to consider include the following:

- Through the LinkUp program, aid in the testing, demonstration, and marketing of glass fines in the construction industry. Market glass fines to LEED projects as a recycled material, and study other potential higher-value uses, such as fused glass pavers, tiles, and other specialty products.
- Consider purchasing glass fines for use in County infrastructure projects.
- Conduct research to determine specifically where in the supply chain that glass quality is being degraded and to identify solutions. This problem harms the marketability of glass, resulting in more material that must be marketed to alternative end markets, such as the construction industry.
- Be prepared to conduct analyses to affirm or refute King County's commitment to glass recycling. As the economics of glass recycling struggle, and if national trends gain traction here, King County may be faced with financial pressure to discontinue glass collection.

Yard Waste Compost

Situation

The recovery, composting, and marketing of yard debris are a recycling success story in King County. In 2002, an estimated 110,000 tons of material were collected from residents and businesses in King County (outside Seattle), with an additional 53,000 tons collected from Seattle. An estimated 220,000 cubic yards of material are sold each year as compost in King County/Seattle, much of this as bulk – but some as bagged product under the Cedar Grove label. Success has been achieved largely because of the County's ban on yard waste disposal

at the curb and due to promotional campaigns that educate the public about the benefits of using compost as a soil amendment. In addition, the private sector has invested heavily in compost facilities, and processing issues such as odor have been addressed over time.

Nonetheless there is more that can and needs to be done to further develop yard waste compost markets. Despite and in part because of this success yard waste compost rated high on both the needs and opportunity assessment scale. Improvements in compost product quality may help expand markets, particularly in higher-value applications. In terms of opportunities, large quantities of yard waste, nearly 23,000 tons in 2002, are still disposed at transfer stations as part of the self-haul stream. Additionally, the environmental benefits of compost, including reduced fertilizer use and improved water quality for salmon, have not yet been fully realized.

Recommendations

- Ban the disposal of yard waste at all transfer stations and provide recycling incentives, such as reduced tip fees, appropriate infrastructure, and compost products.
- Promote use of existing private-sector collection drop boxes and facilities for yard waste recycling, and where feasible, provide collection of yard waste at County transfer stations.
- Continue education and marketing initiatives to stimulate demand for compost products among residential and commercial end users.
- Continue initiatives to purchase compost for public sector transportation and landscaping projects.
- Assess issues associated with compost quality, and determine whether and how to establish a product quality grading system, including certification and standards. Coordinate with other entities, including the U.S. Composting Council, the Washington State Department of Ecology, and the Washington State Organic Recycling Council on this issue.

Urban Wood

Situation

Hog fuel is currently the major market for wood recovered from the solid waste stream. Until recently, recovered wood was in high demand for use in HomePlate, a composite wood/plastic siding product that Boise Building Solutions is working to develop. This market is currently on hold, however, as Boise stopped accepting recycled wood in April 2004 while it works to address technical production issues at its plant near Elma in southwestern Washington. Due to its low moisture content and dimensions, clean urban wood is particularly desired as feedstock for this product application. If Boise reopens in 2005 and the product proves successful, this operation could contribute significant jobs and

economic growth to the region as well as a large market for urban wood. Some niche markets also use recovered wood to create value-added products.

The private sector is aggressively implementing recovery programs for this material. A significant quantity of wood waste remains in the waste stream, however – an estimated 73,000 tons annually, with slightly more than half being disposed by self-haulers.

Recommendations

Expanding the supply of urban wood and lowering the cost of recovery represent major market development opportunities for King County. Potential public sector actions include the following:

- Provide wood waste recycling opportunities at all King County transfer stations, as facility improvements and resources allow.
- Ban the disposal of wood waste.
- Implement a promotion campaign, perhaps in partnership with the private sector, to encourage self-haulers and commercial operators to take their wood waste to a recovery facility.
- Provide economic incentives for generators to recycle their wood, perhaps through a tip fee differential on loads with a high percentage of recyclable wood.

Electronics

The supply chain and associated markets for electronics are in their developmental phase. This marketplace is characterized by rapid change, with many new entrants as well as uncertainties about key elements of the supply chain, including questions about economic viability, durability, and environmental performance.

King County is already playing a major role in the development of markets for obsolete electronics through its active role in collaborative product stewardship initiatives, such as the Northwest Product Stewardship Council, and its pioneering efforts to establish a take-back system for used computers. These efforts are focused on establishing and funding collection and processing systems for electronics. The County has the opportunity to extend the leverage gained through its partnerships to help strengthen end markets and to ensure that collection and processing systems are adequate for anticipated future supply.

Our assessment identified several commodities that comprise the electronics waste stream as high-priority materials for market development focus:

- Leaded glass and cathode ray tube (CRT) monitors and TVs;
- E-waste plastics and peripherals, which are mostly made of plastic;

- Liquid crystal display (LCD) monitors; and
- Central processing units (CPUs) from computers.

Needs, opportunities, the ability to influence, and possible government actions are different for each of these materials. The current situation and initial recommendations for possible King County action for these materials are highlighted below.

CRTs & Leaded Glass

Markets for CRTs and its main constituent element, leaded glass, are problematic. Domestic markets for recycling CRT glass back into the same application (known as glass-to-glass recycling), the current highest and best use, are unsustainable, as CRT television and computer monitor production is shifting overseas. The primary alternative is to use leaded glass as a fluxing agent in smelters, but current facilities lack the capacity to absorb all of the generation of monitor glass expected over the next several years. The third primary outlet for monitors and leaded glass is the export market, where environmental and worker safety practices are questionable.

King County's ability to influence this market is limited. Given that this issue is global in scope, forming partnerships and alliances to monitor and address CRT and leaded glass market development needs will yield the highest possibility for success. Potential actions include:

- Monitoring the status of domestic glass-to-glass and lead smelter facilities and markets to keep informed of any changes in conditions that might affect the viability of King County's electronic recycling programs.
- Promoting development of a chain-of-custody protocol to ensure environmentally and socially sound processing of monitors and leaded glass overseas. This initiative could be pursued in conjunction with other concerned local and/or state governments, such as Portland Metro, through the Northwest Product Stewardship Council.
- Engaging manufacturers through a product stewardship approach to support more aggressive actions to ensure adequate markets for leaded glass.

E-waste Plastics & Peripherals

Our market research found that much of the plastics collected for electronics recycling are disposed. This finding holds true for peripherals such as keyboards, which are primarily made of plastic. The obstacles are many, and only two types of plastics found in computer equipment are of interest to end markets: ABS (including the related PCABS) and HIPS. These plastics are found primarily in monitors and CPUs. However, these plastics can be difficult to identify or separate from other less marketable plastics. Other barriers include the many different types of plastics used in computer equipment and the lack of cost-effective sorting technologies or facilities for these plastics. The extensive use of the potentially hazardous polybrominated diphenyl ethers (PBDEs) as a

flame retardant embedded in plastics creates an additional barrier to recycling. Since computers are increasingly being made of plastic, rather than metal, market issues associated with electronics recycling are likely in increase, rather than abate, over the next several years.

As with leaded glass and monitors, the County's ability to significantly influence e-plastic end markets is constrained. Gaining leverage through product stewardship initiatives and partnerships is recommended as a preferred strategy. Possible actions include:

- Focus product stewardship efforts on "design for recycling," engaging manufacturers in efforts to either reduce the different types of plastics used or find cost-effective means of recycling these plastics.
- Support Washington's state-level efforts led by the Department of Ecology to develop a Chemical Action Plan to manage PBDEs and find alternative flame retardants. Safer alternatives will remove one barrier to recycling of e-waste plastics.
- Through LinkUp or other technical assistance efforts, investigate the feasibility and economics of using e-plastic waste in non-traditional applications, such as in construction or public works projects.
- Conduct follow-up research into the status of automated sorting technologies pioneered by MBA Polymers with support from the American Plastics Council. Determine if this technology is likely to be commercially viable in the near future and the potential for a facility using this technology to take King County plastics for processing.

Liquid Crystal Display (LCD) Monitors

Recycling of LCD monitors is in its infancy. Our research identified only one end market for these monitors. A great deal of uncertainty also exists about what materials are actually in an LCD monitor and the potential value and toxicity of those materials.

Currently, the relatively few non-working LCD monitors collected to date from King County households and businesses are being stockpiled at a local processor. This processor reports that although the recycling procedure for LCD monitors is still under development, it will likely involve removal of the fluorescent tubes (which may contain mercury) before further processing or shipment.

The opportunity for King County is to work with industry and other government entities to develop a supply chain and markets for LCD monitors before they become a major problem, thereby averting the situation currently experienced with CRTs. Possible actions include the following:

- Conducting research into the components of LCD monitors, specifically determining the value, toxicity, and current recyclability of those elements.

- Encouraging public-private partnerships to establish King County as a regional or national center for dismantling and reprocessing of LCD monitors.
- Engaging manufacturers in developing solutions to LCD monitor recovery, using the product stewardship model.

Computer Central Processing Units (CPUs)

Circuit boards and the precious metals contained within them and scrap metal are the primary marketable materials found in obsolete CPUs. Revenues from these items, as well as the front-end fee charged for processing, largely fund the recycling of obsolete electronics.

King County does have the ability to influence the CPU supply chain, primarily by stimulating supply. Recommended actions include 1) continuing to develop collection systems like King and Snohomish counties' Take-It-Back Network (a collecton of businesses who accept used electronics for recycling) and other retailer-based recycling programs; and 2) educating consumers and businesses about the existence of these collection services and the importance of recycling rather than disposing of obsolete computer equipment.

Remaining High-value Materials

Situation

Significant quantities of readily recyclable and high-value materials remain in the waste stream. In particular, an estimated 160,000 tons of recyclable paper, PET and HDPE bottles, and aluminum cans – worth an estimated $19 million – are still disposed by businesses and residents in King County. These quantities represent a lost opportunity to benefit the economy and the environment.

Recommendation

Although King County has relatively little ability to influence the end markets for these materials (due to their national or international nature), the County does have some degree of influence over their collection and supply. Accordingly, King County could take the following action:

- **Adopt strategies to increase supply of high-value materials.** King County could utilize supply-side tools – such as increased level of service (including increased commercial or public place recycling), education and promotion, technical assistance, or bans and mandates – to realize the benefits of increased recycling of these materials.

Chapter 4
Electronics

4.1 INTRODUCTION

Obsolete electronics – such as computers, televisions, printers, cell phones, stereos, videocassette recorders, and other office and household electronics – are one of the newest and in many ways most problematic material in the waste stream today. Although electronics themselves are not new – they have been purchased, used, reused, recycled, and disposed in relatively small quantities for many years – the quantity of obsolete electronic items requiring recycling or safe disposal has grown dramatically in recent years. This increase has been driven in large part by the ubiquity of personal computers and other electronic items in the home and office and by rapid changes in technology that can render products obsolete before they are even two years old.

Markets for reused and recycled electronics have also existed for some time. Charities and other electronics resellers have resold electronic equipment for low cost, and scrap recyclers have dismantled electronic items to recover marketable components, largely scrap metal. The recent growth in the quantities of obsolete electronics, however, has overwhelmed existing outlets and required the development of new markets and supply chains to collect, disassemble, and process the component parts into commodity materials and, ultimately, into new products.

This chapter provides a summary of current market conditions for electronic wastes, followed by an assessment of key needs and opportunities associated with the local electronics supply chain. Please note that the focus of this chapter will be on the recycling of electronics into commodity materials (rather than resale), with a particular focus on cathode ray tubes (CRTs) from both computers and televisions, central processing units (CPUs) from computers, and computer peripherals. Information on other types of electronics, however, will be provided where available.

Please note that in this chapter we refer to *collectors* as organizations that accept or collect used electronics from the public, including repair shops, retail stores, charities, transfer stations, waste hauling companies, and others. We refer to *processors* as companies that disassemble, demanufacture, or otherwise reduce electronic items into component parts for sale to *end markets* – firms that transform those materials into new feedstocks or products. In some cases, firms may perform a combination of these activities.

From December 2003 through April 2004, we collected information on electronics recycling markets from four types of sources. First, we reviewed local studies on electronics recycling. Second, we conducted telephone interviews with four local recyclers. Third, we interviewed other industry players, including a collection company and two commodities processors. Fourth, we conducted a literature

review to address issues that arose from interviews and to gather further information.

4.2 MARKET CONDITIONS

Trends & Key Variables Affecting Supply

Most households and businesses in King County own electronic equipment, meaning that now and in the future there will be a significant supply of e-waste generated for recycling, reuse, and disposal. Key facts underscoring this finding include the following.

- **About three-quarters of King County households own computers.** According to supplemental survey data collected by the U.S. Census Bureau in 2001, an estimated 76% of King County households own computers (U.S. Census Bureau, 2002). This amount is higher than both the national average (57% in 2001) and the Washington state average (67% in 2001).
- **Nearly all households own televisions.** King County's annual residential waste reduction and recycling survey found that an estimated 95% of King County households have televisions (King County Solid Waste Division, 2003).
- **Many households are storing unused electronic equipment.** In King County, about 25% of households report storing computers that they no longer use, and 16% report storing televisions (King County Solid Waste Division, 2003).
- **Businesses in King County outside Seattle are using an estimated 350,000 computers.**[4] The number of computers per employee in businesses ranges from less than 0.2 (in food service) to about one per employee in most offices to over 1.3 in schools (Energy Information Administration, 1999).

The above facts and estimates indicate the ubiquity of computers and televisions in the home and office. Given this high degree of market penetration, significant changes in technology, if adopted on a large scale, could lead to rapid generation of obsolete items. Following are more specific findings regarding the influence of changing technologies on e-waste generation.

- **The increasing availability and decreasing costs of flat-panel monitors will likely lead to increased quantities of CRT monitors being discarded.** Sales of flat-panel computer monitors are rapidly increasing and are projected to overtake sales of traditional CRT monitors for the first time in 2004 (E-Scrap News, 2004c).

[4] This is a Cascadia estimate based on the number of employees in King County (excluding Seattle) and the average number of computers used in each of several industry groups.

- **High-definition and other new TV technologies are slower to catch on, but decreasing prices could cause consumers to make the switch near the end of this decade** (Stanford Resources, 2002). Sales of flat-panel television displays, for instance, have been increasing at a rate of at least 20% annually (Etris, 2003). Still, prices for most items are too high for the average consumer, and so a large market shift is still likely a few years away.
- **The average household computer is used by its original owner for about three years** (National Safety Council, 1999). In the business environment, computers have also commonly been replaced on approximately three-year cycles; however, in many businesses this life cycle has increased to up to six or seven years due to economic slowdown and the practice of cycling high-end computers down to users that do not require the power of the newest model (Tech Update, 2003).

Estimates of Current Supply

Estimates of the current supply of obsolete electronics have been developed by Cascadia as part of other work for state and local governments in the Puget Sound region. Findings from these studies, new estimates based on similar modeling methods, or estimates based on a survey of local electronics recyclers are presented below.

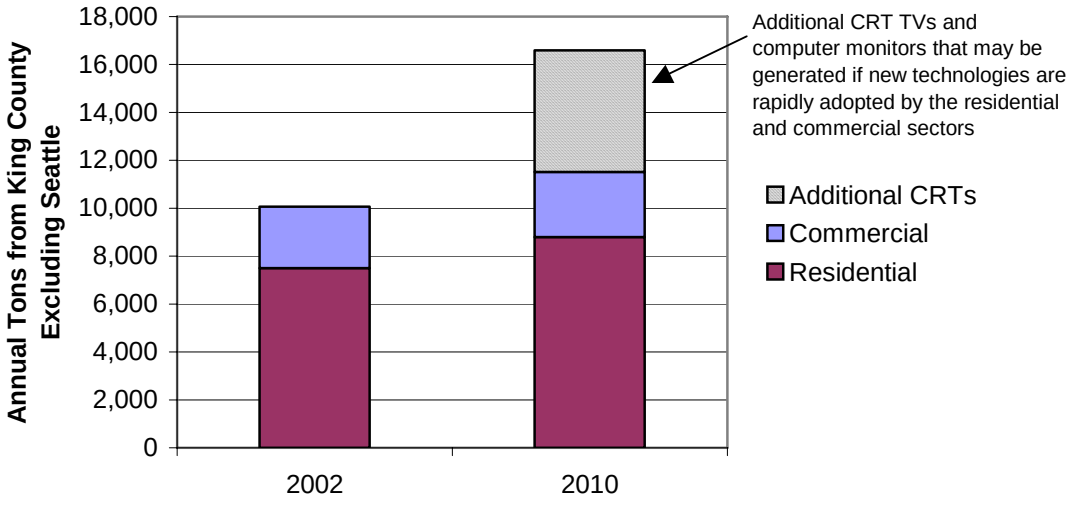
- **King County residents generated an estimated 7,500 tons of obsolete computers and televisions in 2002.** Cascadia recently estimated the generation of e-waste in Seattle and Northwest Washington (Cascadia Consulting Group and Sound Resolutions, 2003). Applying this method to King County excluding Seattle yields estimates of 413,000 items, weighing a total of 7,500 tons. These items, termed "obsolete," could be given to friends or family, resold, donated, recycled, stored, or disposed.
- **All King County businesses generated an estimated 2,600 tons of obsolete computers in 2002.** Cascadia again applied the method it used in its study *E-Waste Generation in Northwest Washington* to King County excluding Seattle to derive this figure.
- **Recyclers reported recycling at least 138 tons of computers, televisions, and other electronics from King County in 2002.** The actual total is likely 1.5 to 2 times higher, as several recyclers did not respond to the survey conducted for this study.
- **Approximately 4,400 tons of electronic items were disposed in 2002.** Recent waste composition studies show that about 4,400 tons of electronic items were disposed from residential, commercial, and self-haul sources (Cascadia Consulting Group, 2004).
- **The ultimate disposition of most of the generated electronic items is unknown.** The disposition of the more than 5,500 tons of e-scrap estimated to be generated in 2002 but not disposed or recycled is

unknown. Much of it is likely reused by friends, relatives, or associates; recovered through "asset recovery" programs at businesses; donated to other organizations; or stored.

Projected Supply

Cascadia estimated the current and future generation of obsolete computers and televisions, as follows. Note that these estimates do not include computer peripherals or other household or business electronic waste, such as stereo equipment, copiers, fax machines, cell phones, or other items. The flow of these items is likely to add significant quantities to the total quantities of e-scrap generated. As shown in Figure 4-1, in 2002 residential users generated an estimated 8,800 tons of computers and televisions and commercial sources (including small and large businesses alike) generated nearly 2,600 tons.[5] These quantities are expected to increase at least 15% by 2010 assuming continuation of current trends. However, the quantities generated in 2010 could increase as much as 65% over 2002 levels if rapid adoption of television and computer monitor technologies cause consumers to stop using existing technologies.

Figure 4-1. Generation of Computers and Televisions in King County: Current and Projected
(excludes Seattle)



[5] The commercial figure does not include televisions, because most televisions are assumed to originate from the residential sector and no means of estimating how many televisions were in use in the commercial sector could be devised.

Collection

While the presence of electronics in the home and office has been increasing, options for discarding obsolete electronic items have decreased. In particular, some items are now banned from disposal and are no longer accepted by charities, as discussed below.

- **Both King County and Seattle restrict the disposal of computer monitors.** King County bans businesses from disposing of computer monitors as garbage. Seattle bans the disposal of all items that contain cathode ray tubes (CRTs) from both residents and businesses. The items are banned for resource conservation purposes and because they fail Toxicity Characteristic Leaching Procedure (TCLP) tests.
- **Most local charities and thrift stores no longer accept televisions or computers for resale.** Faced with large quantities of broken or low-value items, most local non-profit and other thrift stores have stopped accepting televisions and computers. For some stores, items that were not saleable were costing thousands of dollars each year in recycling costs. Despite these policies, many thrift stores still receive unwanted donations of obsolete computers and televisions at their drop boxes or left overnight at their locations.

Faced with the increasing prevalence of obsolete electronics and bans on their disposal, local governments and the private sector have formed partnerships to offer reuse and recycling opportunities. These partnerships – and related policy initiatives – have been gaining traction at the local, regional, and national levels and are expected to result in a significant increase in recovery of electronic equipment for reuse and recycling. The following sections covers these local, regional, and national efforts.

- **Curbside electronics recycling is becoming more common in King County.** Several cities on the Eastside (Bellevue, Kirkland and Redmond) have recently expanded their residential waste and recycling contracts to collect electronics and small appliances from single-family households. Several other cities in King County are also considering adding electronics to their curbside collection of recyclables. Residents are asked to set large electronics two feet from their recycling bins and to set small electronic items, such as cell phones and computer peripherals, in clear plastic bags next to the recycling bins.
- **King County and Snohomish County have partnered with local shops and recyclers to provide the Take-It-Back Network.** The Take-It-Back Network is designed to offer residents and businesses environmentally responsible and convenient recycling destinations. To join the network, program partners (repair and resale shops, non-profits, and recyclers) must take a pledge not to export hazardous components

for processing. Program partners are featured on the program website so that residents can easily find opportunities anywhere in the region.[6]

- **Washington State adopted e-waste legislation in 2004.** As introduced in January 2004, House Bill 2488 required electronics manufacturers to design, establish, and finance a plan for the collection and recycling of electronics waste. After the state House and Senate passed amended versions of the bill, in March 2004 Governor Locke signed the e-waste legislation into law. The new statute requires the Washington State Department of Ecology to work with the state Solid Waste Advisory Committee to research and develop recommendations by the end of 2005 on how to implement and finance a program for collection, recycling, and reuse of electronic products.
- **A product stewardship alliance is working to establish a national electronics recycling program, though financing remains a problem.** A group of government, non-profit, and industry (including Panasonic, Dell, and Sony) stakeholders are working together on the National Electronics Stewardship Initiative (NEPSI). The initiative focuses on product stewardship, which is a shared approach of manufacturers, retailers, consumers, and others to reducing the environmental impact of electronics throughout their lifecycle and ensuring proper management at the end of their use. In February 2004, after three years of meetings, the group agreed to endorse a resolution to develop a nationwide recycling system. As part of this resolution, the Electronics Industry Alliance (EIA), a charter member of NEPSI, agreed to create a proposal for legislation that NEPSI will introduce to Congress (EIA, 2004). The finance mechanism for such a system remains a point of contention, however. Discussions have focused on using, at least initially, an advanced recycling fee charged on the sale of certain electronics, though the participants have not been able to reach consensus on a financing framework (E-Scrap News, 2004d).
- **Some manufacturers have begun offering recycling services for end-of-life electronics.** In response to consumer pressures, several major electronics manufacturers, including Dell, HP, IBM, and Panasonic, are now offering some form of recycling program such as product mail-back or special recycling events. For instance, for $29.99 IBM will send a prepaid package and instructions to recycle any manufacturer's computer, including monitor, CPU, printers, and any other attachments[7]. Retailers are also providing services. Best Buy and Staples, for example, have each partnered with manufacturers and recyclers to collect computers and other electronics at store events.

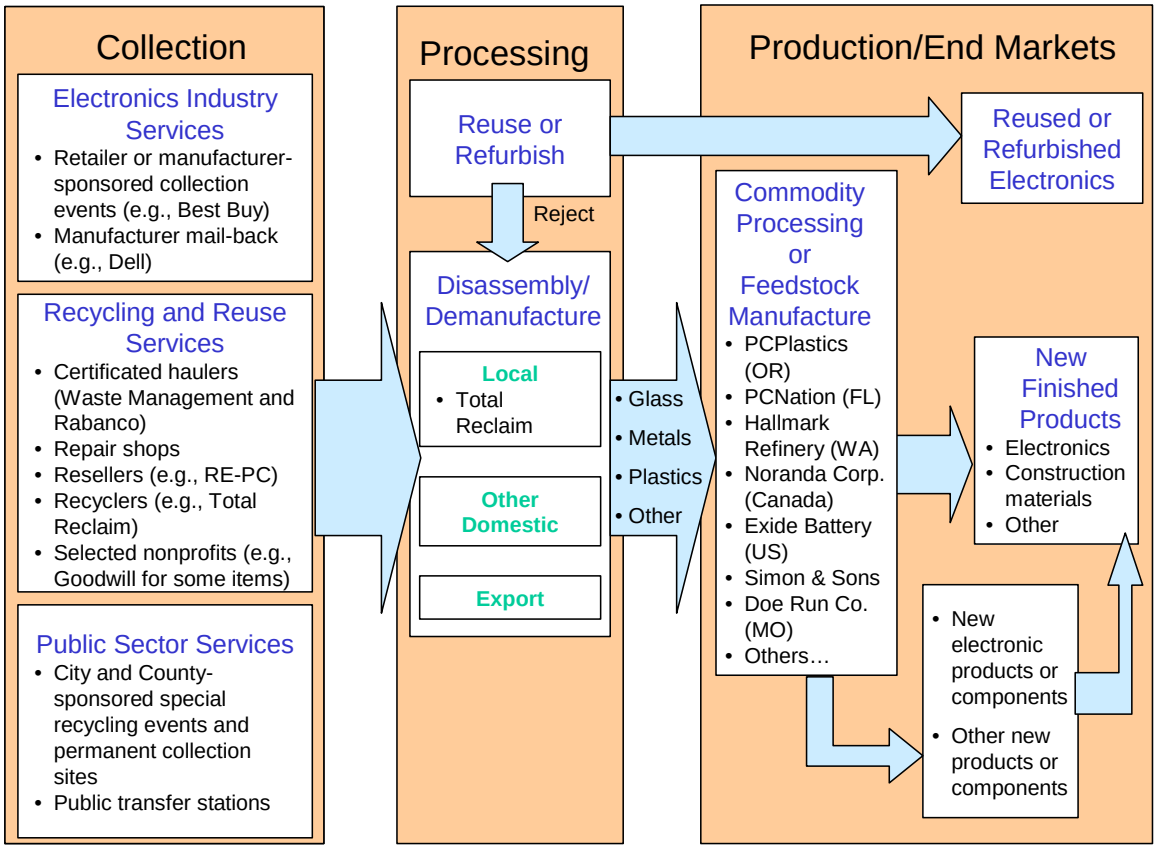
[6] Take-It-Back Network website, dnr.metrokc.gov/swd/takeitback/.

[7] http://www.ibm.com/ibm/environment/products/pcrservice.shtml

With restricted options for disposal and donation, new alternatives are developing to enable the recycling of unused electronics. However, more options will clearly need to be available if the quantities of materials stockpiled and generated are to be responsibly managed. As electronics recycling becomes more prevalent and begins to move into the mainstream, some debate has shifted to who should bear the brunt of the cost of recycling e-waste. The ongoing product stewardship dialog, both regionally and nationally, will likely help shape the financing system and the relative responsibility of consumers, manufacturers, and governments in the next few years.

Figure 4-2 summarizes the variety of collection services available in King County, and provides an introduction to the remainder of the supply chain for recycled electronic items. Following chapters will discuss e-waste processing and end markets.

Figure 4-2. Current Flows of Electronic Waste Generated in King County



Please note that organizations listed as collectors may in some cases perform some disassembly or processing activities and may market some components or materials directly to end markets.

Processing

After sorting items by type (e.g., CRT monitors, CPUs, TVs, consumer electronics), e-waste processors utilize a variety of methods to dismantle the items and prepare component materials for market (see sidebar). Hand disassembly (using electric screwdrivers, pry bars, and other tools) is a common means of removing an item's outer shell and, in many cases, internal parts. Hand disassembly generally produces the highest quality marketable products, but can be time-consuming and expensive. As an alternative to hand disassembly, one local processor is also operating a shredder that processes some items without any prior disassembly. The company hopes that the shredder and its associated separators will be able to process items and automatically sort them into distinct, marketable materials. Regardless of the method used, e-waste processors must meet the needs of their end markets.

Computer Monitors with Cathode Ray Tubes

The first step to recycle a monitor is to remove the plastic back. The monitor is then separated into the circuit board, degaussing cables, metals, and cathode ray tube (CRT). All non-glass material, including the copper wire yoke, is removed from the CRT prior to shredding. A monitor weighs about 30 pounds, 50% of which is a cathode ray tube, 25% is plastic, 13% is circuit boards, 6% is metal, and 4% is wires (Townsend, 2002).

Laptops & Flat-panel Monitors

Flat-panel monitors and laptops are manually separated into fluorescent bulbs, liquid crystal screens, plastic, circuit boards, and metals. After the screen is removed, laptops can be shredded. The recycling procedure for LCD screens is under development, but it will likely involve removal of fluorescent tubes before further processing.

Computer Central Processing Units

CPUs are disassembled into hard drives, plastic or metal covers, batteries, and circuit boards. They can also be shredded after the circuit board is removed. CPUs weigh about 25 pounds on average. By weight, a CPU consists of a metal casing (45%), disk drives (17%), power transformer (15%), wiring boards (10%), plastic casing (8%), wiring (3%), and other miscellaneous parts (2%) (Townsend, 2002).

Televisions

Standard televisions are manually separated into CRTs, plastic covers, speakers, and wiring. TVs are frequently too large for shredding machines (if available) so are manually disassembled. A 15- to 21-inch screen television weighs an average of 42 pounds; larger televisions average 125 pounds.

Processors handling electronics from King County consist of a mix of local, regional, national, and foreign companies. The points below provide a brief overview of these companies.

- **King County-based Total Reclaim is the largest processor in the region, though some smaller firms also handle electronics.** Total Reclaim handles an estimated 80% of all e-waste material processed in the Northwest. Although its core business is processing, Total Reclaim also salvages and redistributes working computer systems through a partnership with the non-profit World Computer Exchange. Used computer retailers, such as RE-PC and PC Salvage, also handle and disassemble some obsolete electronics. These companies operate retail stores and are primarily resellers. As such, they focus more on refurbishing and reselling computer systems than on dismantling their

components. They do dismantle some items for recycling, however, such as CPUs and peripherals, and they ship other products, such as CRTs, to processors like Total Reclaim.

- **Total Reclaim has positioned itself to increase its throughput dramatically by acquiring a shredder.** In late 2003, Total Reclaim installed a system to shred a wide variety of electronics and sort the resulting material stream. Total Reclaim expects that the shredder will allow the company to double its processing capacity, decrease labor costs, and access a wider variety of end markets. In some cases, material streams produced by the shredder may not be marketable to the same end users as hand-disassembled materials, due to contamination. However, markets do exist for the materials, and Total Reclaim is hoping that the increased flexibility will be an advantage in the marketplace.
- **Processors based elsewhere in the region also provide services in King County.** For example, Earth Protection Services, based in Portland, serves a number of King County customers, including local businesses as well as state and federal agencies. The company operates a processing facility and drop-off location in Portland, Oregon, where they consolidate material from Montana, Washington, northern California, and occasionally Wyoming and Alaska. Computers are demanufactured at the Portland facility. Televisions, lamps, and ballasts are processed at their facility in Phoenix, Arizona. Currently, ballasts, batteries, and fluorescent lights represent about 80% of their work and electronics are about 20%, although the electronics share is reportedly growing steadily.
- **Local and regional processors report that they are able to handle more material.** All processors interviewed reported they are currently operating below capacity and could handle more material. Earth Protection Services, for instance, recently moved into a new Portland facility to accommodate an increased throughput and said they foresee moving again for future expansion at some point.
- **An unknown quantity of e-waste is processed outside the region, including in Asia.** Local and regional processors are not the only companies that process material generated in King County. For example, local e-waste collector Philip Services Corporation sends its material to NxtCycle, which processes the material at a prison in Utah. Other local collectors export electronics to other countries, typically in Asia, for dismantling. The pressure and economic incentive to export items for processing is reportedly quite strong. For example, several local processors report receiving daily calls from overseas processors offering to *purchase* intact electronic items. One such processor was concerned that any company offering to purchase monitors is likely handling them inexpensively, and possibly illegally, to recover valuable components. No data were available on the quantities of electronic items being exported.

- **The economics of e-waste recycling rely heavily on recycling fees, as processors generally receive little (if any) net income from marketing the processed materials.**[8] Table 4-1 provides a summary of the recycling fees charged by local e-waste processors.

Table 4-1. List of Fees Charged at Selected Local E-waste Processors

COMPANY	ITEM	COST
PC Salvage	Monitors and TVs	$10 and up
	PCs, laptops, printers, scanners, fax machines, and copiers	$5 and up
	Keyboards and mice	$1
	Cell phones and PDAs	No charge
Philip Services	Monitors or TVs less than 28"	$8.50
	TVs over 28"	$11.50
	Big screen TVs	$25
	PCs, laptops, printers, keyboards, mice, scanners, fax machines, copiers, cell phones, PDAs, VCRs, DVDs, stereos, and CD players	$0.25/lb
RE-PC	Monitors	$10
	PC	$5
	TVs less than 19"	$25
	TVs over 19"	$35
Total Reclaim	Monitors and laptops	$10
	TVs	$0.25/lb
	Cell phones	$2.50
	PDAs	$2
	Printers, keyboards, mice, scanners, fax machines, copiers, VCRs, DVDs, stereos	$0.35/lb

Source: King County Solid Waste Division Take it Back Website, dnr.metrokc.gov/swd/takeitback, March 2004.

In summary, due to the lack of data on how much e-waste is shipped out of the region, it is unclear whether local processors could handle all electronic waste generated locally. Significant potential exists to increase processing locally, though it will be difficult for local processors to compete with export markets without some other market influence, such as regulations or consumer demand against exporting.

[8] This situation is largely a result of the high tip fees that processors pay to recycle the leaded glass common in CRTs. The next section on *End Markets & Prices* discusses the value of various e-waste commodities.

End Markets & Prices

When processors dismantle electronic items, they produce the following components:

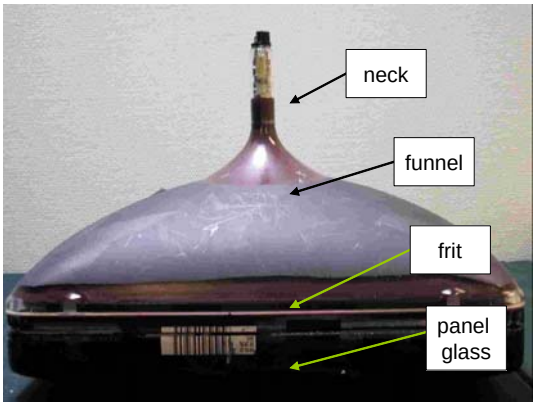
- **Cathode ray tubes (CRTs),** which are composed primarily of glass;
- **Circuit boards**;
- **Plastics**;
- **Scrap metal**, including steel, copper, and aluminum; and
- **Flat-panel monitors** (e.g., liquid crystal displays, or LCDs) or their constituent components.

This section discusses how and where Northwest *processors* commonly market the above materials. In general, the largest King County processors send most (but not all) materials to domestic markets, and so domestic markets are the primary focus of this study. Please note, however, that some companies that *collect* e-waste in King County send the intact items overseas for processing. Due to the difficulties of tracking these items and researching the processing practices in overseas locations, this study did not include extensive research into export markets.

Cathode Ray Tubes (CRTs)

A cathode ray tube (CRT) is a "picture tube" that is the primary component of a traditional monitor or television. CRTs are composed of three pieces of glass: neck glass, funnel glass, and panel glass. In addition, a lead-glass solder mixture called "frit" joins the funnel and panel. All three types of glass include some lead content: the funnel glass is approximately 25% lead; the neck glass is about 30% lead; and the panel glass is between 0% and 3% lead (Musson, 2000). Manufacturers include lead in the glass to shield the user (and others who may be nearby) from radiation. This lead makes the CRTs potentially hazardous, however, leading King County to ban their disposal by some generators. In fact, CRTs are estimated to account for 30% of all lead in municipal solid waste (Musson, 2000). Recycling is expensive, however, and electronics processors must pay large fees to have CRTs recycled into new CRTs or used as a fluxing agent in lead smelters.

Figure 4-3. Major Parts of a Cathode Ray Tube (CRT)[9]



[9] CRT photo source, www.proventia.fi.

- **The largest market for CRT glass is currently new panels, but this market is declining as flat-panel displays replace CRTs.** Dlubak (with facilities in six states) and EnviroCycle (in Pennsylvania) both manufacture new glass for CRT production. These companies charge recyclers about $0.06/lb plus $0.02-$0.04/lb shipping (for a total of up to $0.10/lb or $200/ton) to accept CRT glass.[10] They process the glass for sale to one of only three CRT monitor manufacturers in the United States: Techneglas Inc., American Video Glass Co., and Thomson. Domestic CRT production is expected to dwindle, however, as manufacturing moves offshore and the U.S. monitor market converts to flat-panel technologies (Toto, 2003). One market research firm suggests sales of CRT computer monitors will end in developed countries in 2007 (E-scrap News, 2004). Unless other CRT glass markets are found to replace the glass-to-glass market, glass will likely be sent to smelters or to CRT manufacturing plants overseas.
- **CRT glass can also be used at smelters, although prices are higher and capacity is much lower.** Primary lead smelters produce lead from virgin ore and secondary lead smelters recover lead from existing products, such as lead-acid batteries. Both types of smelters are generally able to use CRT glass as a fluxing agent (to help remove impurities in their lead product), and in most cases recover the lead embedded in the glass for productive use. Smelters will not likely be able to serve as a viable replacement for the diminishing glass-to-glass market, however, as their combined capacity is less than 10% of that of the current glass-to-glass market (Musson, 2003). Doe Run operates the only primary lead smelter in the country in Missouri; the company also operates a secondary smelter in that state. Exide Technologies operates six U.S. secondary lead smelters for battery recycling; electronics recyclers pay approximately $0.15/lb to send CRTs to these facilities. In addition, other companies operate approximately 10 other facilities in the U.S. (Smith, 2000). Canada has several lead smelters, including one in Trail, B.C.
- **Whole CRTs can be sent directly to smelters for processing.** Intact CRTs (and in some cases whole TVs or monitors) can be shipped to Doe Run and some other smelters for processing. For processors, the main difference between shipping crushed CRT glass and whole CRTs is the cost of shipping. Because whole CRTs take up considerably more space than when crushed, the cost to the processor is far greater. A truck trailer can handle up to twice as much material, by weight, when the glass is crushed (Lorch, 2004b).
- **New technology may be developing to remove lead from CRT glass**. The Industry Council for Electronic Equipment Recycling (ICER) of England has recently completed a study on various techniques for

[10] The companies do not accept neck or funnel glass due to the lead content.

removing lead from CRT glass, but as of this writing the report is not yet available.[11] At least one company, NuLife Glass in England, reports to have developed technology to separate the lead from leaded glass.

Circuit Boards

Circuit boards recovered from used electronics are sold to refineries that recover the precious metals. Due to this precious metal content, circuit boards are the most valuable component (by weight) reclaimed from used electronics. Not all circuit boards are the same, however. For example, circuit boards in computers are more valuable than circuit boards from telephone equipment or TVs. In addition, newer, less expensive computers have less valuable circuit boards that contain a smaller amount of precious metals.

- **Hallmark Refining buys and processes higher-value, intact circuit boards for sale to smelters.** Depending on the market, they sometimes also accept lower-value circuit boards. Hallmark shreds the boards and incinerates a sample from a load to be tested for precious metals content. The fee paid to the processor is based on the content of the precious metals in this assay. Hallmark can pay between $0.10 and $1.00/pound for circuit boards, depending on the quantity and market value of the metals, which typically include gold, silver, and palladium. Hallmark sells shredded boards to Noranda or similar smelters in Germany and Belgium (Senff, 2004). About one-third of the circuit boards may contain nickel-cadmium or lithium batteries, which are particularly common on motherboards from CPUs. Batteries are often removed by hand prior to processing and sent to a battery recycler. Batteries are not always removed, however, particularly with newer systems. Some smelters also accept circuit boards with batteries for processing and recover the toxic components along with other contaminants during the smelting process.
- **In some cases, processors can sell shredded circuit boards directly to smelters.** Most circuit boards recycled from the region travel through Hallmark Refining on their way to a precious metal smelter, but some processors can sell shredded circuit boards directly to smelters. At the smelters, circuit boards are burned: non-metal materials such as plastic provide fuel, and the remaining, molten metals are recovered, analyzed, and further separated. One use for precious metals recovered in this process is jewelry.
- **Only one company in North America recovers precious metals from circuit boards.** In North America, the only company that offers this service is Noranda, through its smelter in Quebec, Canada. Noranda has recently had difficulties with its labor force, however, and therefore may be a potentially unstable end user. According to one industry

[11] http://www.icer.org.uk/index.htm

contact, only two or three smelters in the world, including Noranda, are reliable and capable of handling large quantities of these materials (Senff, 2004).

Plastics

Plastics recovered from electronic items may be remanufactured into new plastic products, burned as fuel, used for alternative daily cover, or landfilled. Many obstacles currently limit plastics recycling, however, including identification of resins, development of markets, and the presence of fire-retardant chemicals. These and other characteristics of the marketplace for plastics recovered from electronic items are discussed below.

- **Identification of plastic resins is necessary for recycling, but can be difficult.** Although some manufacturers do label plastic components with a resin code or other identifying information, e-waste processors report that in many cases labels are difficult to find or nonexistent. Identifying resins is particularly difficult and time-consuming for smaller plastic items other than an item's housing.
- **Most markets for e-waste plastics have been in Asia.** In recent years, most plastics recovered from electronic items have been marketed to Asia, due to lack of domestic markets. Currently, many e-waste plastics still are being sent to China or other Asian countries for material recovery and manufacture.
- **A new domestic market has emerged in Portland, Oregon.** Until recently, regional demand for e-waste plastics has been low to non-existent, and the nearest major e-waste plastics reclaimer was PlasticNation in Florida. Formed in 2002, however, PC Plastics is a new, growing company that has positioned itself to be a leader in the Northwest e-waste recycling industry. PC Plastics accepts HIPS (high-impact polystyrene), common in television housings, and ABS (acrylonitrile butadiene styrene) and PCABS (polycarbonate acrylonitrile butadiene styrene), common in computer monitor housings (Gogol, 2004). PC Plastics currently processes about 40,000 pounds of HIPS per month and has the capacity to recycle up to 110,000 pounds of plastic per month. The company is currently stockpiling ABS, however. PC Plastics sells its HIPS to Panasonic to manufacture new television parts, including housings, and the demand for HIPS is currently greater than the company can supply (Gogol, 2004).
- **Smaller plastic components are virtually unmarketable.** Aside from the large pieces of plastic that typically make up the housing (or shell) of electronic items, recycling of smaller pieces of plastics is difficult. These small plastic parts are often bound with other materials, such as cable and wiring, structural foam, cardboard, circuit boards, speaker magnets, mercury switches, batteries, or hazardous materials. Small plastic parts may also be contaminated with paints, liquids, or powders (MBA Polymers, 1999). Identifying and purifying these plastic pieces

necessitates either high labor costs or expensive sorting equipment. One study by the American Plastics Council on sorting technologies suggests that new market development as well as more efficient sorting equipment may make recycling mixed plastics more economical (APC, 2000).

- **End-market prices or fees vary by resin**. Processors receive up to $0.03/lb for HIPS, but pay as much as $0.05/lb to recycle the other resins.
- **Flame retardants complicate e-waste plastics recycling.** Most manufacturers embed flame retardant chemicals in plastics that make up electronic products. These flame retardants usually belong to a class of chemicals called polybrominated diphenyl ethers (PBDEs). Research on PBDEs is ongoing, but they have been found to be toxic to the liver and nervous system and disrupt thyroid hormones (Betts, 2003). PBDEs have been found in elevated levels in the blood streams of workers at electronics recycling plants (Sjodin, et al., 1999) and are found in elevated levels in human breast milk in the Puget Sound Region (NEW, 2004). In a 2000 study, MBA Polymers found that 87% of HIPS plastic from televisions contained flame retardants (APC, 2000). Some equipment manufacturers are interested in discontinuing the use of brominated flame retardants due to toxicity concerns (Fisher, 2004).
- **New sorting equipment may be able to separate different plastic resins as well as plastics with PBDEs.** With support from the American Plastics Council, MBA Polymers has developed sorting equipment to separate recovered plastics into various individual streams (APC, 2003). In January 2004, the Richmond, California based company announced that it plans to open its first commercial-scale plant in China (Toloken, 2004). They are reportedly not considering a similar investment in the U.S. due to the lack of a large-scale collection infrastructure (Toloken, 2004). Whether the new Chinese facility will eventually be a market for local processors remains to be seen – it will probably depend on price and material specifications.
- **For a fee, mixed plastics can be burned for fuel or used as alternative daily cover.** One processor reported sending plastics to be shredded and used for alternative daily cover. Another interviewee speculated that plastic material from electronic waste is frequently burned for fuel (Gogol, 2004), although none of the processors interviewed reported sending plastics to this market.

Scrap Metal

CPUs contain the majority, by weight, of scrap metal recovered from used electronics. Local processors sell steel, copper, and aluminum to local scrap metal dealers, such as Seattle Iron & Metals, Calberg, and Simon & Sons. Scrap metal dealers pay $0.01 to $0.04/lb for steel. Copper is selling for between $0.50 and $0.90/lb and aluminum is sold for up to $0.50/lb.

LCD Monitors

Domestic sales of flat-panel, liquid crystal display (LCD) monitors are expected to overtake CRT monitors in 2004 (E-Scrap News, 2004c). LCD and other flat-panel monitors are still a relatively new technology, however. Since they have not yet appeared in the waste stream in significant quantities, no standard recycling method has been developed. Total Reclaim is now inquiring with manufacturers to understand what materials make up the liquid screen in LCD monitors. Based on the results, the company will decide whether to dispose or to recover the materials. At a minimum, Total Reclaim plans to recover and recycle the fluorescent bulbs behind the screen (Lorch, 2004b). Whole LCD monitors are reportedly accepted at a facility in New York for manufacturing new monitors, but their processing method for these LCDs remains unclear (Bracking, 2003).

4.3 BARRIERS & OPPORTUNITIES

The previous discussions indicate several of the challenges of e-waste recycling. These and other barriers to increased recycling of electronics are discussed below.

- **Only a limited number of companies can recover precious metals from circuit boards.** An industry expert suggests that only three such companies exist in the world, and only one is in North America (Senff, 2004). Processing capacity appears to be sufficient for current supplies, but the limited number of smelters reduces competition, stability, and diversity in the marketplace and increases transportation costs.
- **No markets exist for many e-waste plastics.** Other than some plastics used in equipment housings (shells), most plastics present in e-waste lack viable markets. Some of these plastics may be burned for energy (for a fee), but the environmental impacts of this practice are not thoroughly documented.
- **The presence of toxic flame retardants in computers and other electronics raises some concern about the safety of recycling e-waste plastics.** Some governments and manufacturers are currently working to limit the use of brominated fire retardants in new products. Accordingly, extending their use through recycling may not be advisable.
- **A major market for CRT glass is expected to dwindle.** As CRT manufacturing moves out of the country, the opportunity to recycled CRT glass back into CRTs will either move overseas or disappear. Today, only about 1.5 million televisions are made in the U.S. annually compared to about 32 million that are sold here (E-Scrap News, 2004c). Interviewed sources agree that U.S. manufacture of CRTs will decrease further and likely not be present at all after seven or eight years. Though flat-panel displays are replacing CRTs in many new products, CRTs will continue to be disposed in the U.S. for a number of years, as consumers replace older TVs and computer monitors. Clearly, alternative end

markets for CRT glass should be explored. Otherwise, the only domestic option will be lead smelters, which have a relatively low capacity.

- **Lead smelters do not provide sufficient capacity to recycle all CRT glass.** Nationally, primary and secondary lead smelters can accommodate less than 10% of what the glass-to-glass market can currently absorb (Musson, 2003). This situation leaves the CRT recycling industry at risk, as smelters – the only current alternative to glass-to-glass recycling – are a limited market.

Several opportunities for enhancing the recovery of electronics are emerging, as covered in the following list.

- **New plastic sorting technologies may enable cost-effective sorting of different types of plastic.** Advanced sorting technologies are just beginning to be attempted on a commercial scale. If successful and not prohibitively expensive, these technologies may enable processors to sort plastics that would otherwise be disposed or sent to other low-value uses. Such sorting technologies would likely focus on plastic resin types and would not help address concerns such as PBDE content.
- **Develop recycling methods for flat-panel displays and laptops now, before they become prevalent in the waste stream.** Flat-panel monitors and laptops have steadily been gaining market share. Traditional desktop computers and CRT monitors, however, still comprise the majority of the computer e-waste currently disposed. Proactive strategies to address flat-panel monitor and laptop recycling, perhaps through a "design for recycling" or product stewardship approach, would bring benefits in the coming years as increasing quantities of these items are collected for recycling. A major barrier, however, is that manufacturers have been unwilling to disclose the content of flat-panel displays, claiming such information as proprietary.
- **Increase availability and consumer awareness of recycling opportunities.** Many residents are stockpiling unwanted electronics, often because they are either unaware of existing services or find them inconvenient or costly.

4.4 PUBLIC SECTOR ACTION OPTIONS

King County could take the following actions to address the barriers and opportunities discussed above.

- **Conduct market research into the potential manufacturing of construction materials derived from electronic waste.** In Ohio, Dlubak, for instance, recently received a grant to expand its facility and research the potential for creating construction materials from CRT glass (E-Scrap News, 2004c). The panel glass could be potentially made into a bead to be used as a filler in cement or in composite building materials

(Toto, 2003). Other manufacturers are experimenting with creating non-skid tiles or decorative bricks from the panel glass (Powell, 2003). Similarly, plastic is being investigated as a feedstock for a family of products known as "plascrete," which may be used for roofing tiles, pavement, and other aggregates. Local government could work with local construction material manufacturers to create opportunities for these new products.

- **Support efforts to limit and find alternatives to PBDEs.** The Washington State Department of Ecology and other organizations have focused toxics reduction efforts on a class of flame retardants known as polybrominated diphenyl ethers (PBDEs), which are frequently used in electronic products. Washington State is currently developing a Chemical Action Plan to address PBDEs. These efforts should be supported as they apply to e-waste plastics.
- **Work in partnerships to apply product stewardship and "design for recycling" strategies to the e-waste problem.** To increase its influence and leverage limited resources, King County should work in partnership with other governments and organizations on joint strategies to engage manufacturers and promote electronics recycling. "Design for recycling" practices may be particularly effective at averting future e-waste problems. Particular attention could focus on toxics, contaminants, and design of products (such as flat-panel monitors) that are still relatively new. LinkUp or other technical assistance efforts could investigate the feasibility and economics of such options as using e-plastic waste in non-traditional applications, including construction or public works projects.
- **Monitor the status of recycling markets for recovered electronic components.** Such efforts are intended to keep King County informed of any changes in conditions that might affect the viability of its electronic recycling programs. Domestic glass-to-glass and lead smelter facilities and markets for recycling of CRTs could be a particular focus.
- **Expand on education and outreach campaign for electronics recycling.** Increase the amount of education to businesses and residents to raise awareness of recycling options and promote their use.
- **Promote monitoring framework for exported electronic waste.** Several processors reported that one of the largest challenges of foreign markets is not being able to trace the path the materials follow, to ensure proper processing, recycling, and disposal. This situation can also occur domestically, though U.S. environmental and occupational safety laws help prevent egregious e-waste pollution and human health impacts. King County could work with other governments and private companies to help establish a chain-of-custody protocol to ensure environmentally and socially sound processing of e-waste overseas, particularly for monitors and leaded glass. This initiative could be pursued in

conjunction with other concerned local and/or state governments, such as Portland Metro, through the Northwest Product Stewardship Council.

- **Encourage public-private partnerships to establish King County as a center for recycling electronics.** Such efforts could include creation of a regional or national center for dismantling and reprocessing of LCD monitors.

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Chapter 5
Glass

5.1 INTRODUCTION

Of all the materials currently collected curbside for recycling, glass may be the most threatened. Although it has traditionally been a hallmark of curbside recycling programs and enjoyed high recycling rates, several factors are combining to dull the success of glass recycling. Most notably, local demand for recycled glass has softened considerably in the last few years due to quality concerns and the decline of the construction market. On the collection side, many haulers are moving towards "single-stream" recycling collection, a method in which glass is collected in the same cart as other materials. If experience in other parts of the country is any guide, single-stream recycling collection often limits the marketability of the glass, and crushed glass pieces can contaminate other recyclables, especially paper. Thus, glass recycling in King County may be approaching a crossroads. Do the County and other stakeholders maintain their commitment to glass recycling, and renew efforts to increase quality and aid market development; or, on the other hand, will King County follow in the path of some other local governments and focus instead on other materials?

The research presented below is intended to give King County a sense of the emerging trends and competing interests in the local glass recycling industry.

5.2 MARKET CONDITIONS

Trends & Key Variables Affecting Supply

As has been the case for many years now, glass containers are collected as part of communities' curbside recycling programs. Private haulers also offer glass recycling to businesses – particularly to large generators such as restaurants. The following key points further describe the status of glass collection and supply in King County.

- **Residential curbside programs are the largest source of glass bottles and containers.** Over 14,000 of the 18,500 tons of recycled glass bottles and containers in King County originated from residential curbside programs.
- **Glass enjoys a 59% recycling rate from King County's residential sector, but this rate has been declining in recent years.** Curbside glass recycling was greater in 1996 than in 2002, both in terms of tons collected and recycling rate.

- **Only about 30% of commercially generated glass bottles and containers are recycled.** This rate has not changed significantly since 1998.
- **"Single-stream" recycling has taken hold in King County.** Some haulers are collecting all residential and/or commercial recyclables (including glass) in a single cart. The material is then sorted at a material recovery facility (MRF).
- **Nationally, many communities are feeling pressure to discontinue curbside glass collection.** The combination of sagging prices, declining quality, and trend toward single-stream recycling are leading many communities to stop (or consider stopping) curbside glass recycling (Powell, 2002). Reports to date from Waste Management's new Woodinville MRF, which handles mostly "single-stream" materials, however, indicate that glass is not causing significant sorting or marketing problems.

Current Supply

The following table summarizes the quantities of glass bottles and containers generated by King County's residential, commercial, and self-haul waste streams. As the table indicates, the total supply of these items in King County (excluding Seattle) is roughly 38,000 tons.

Table 5-1. King County Recyclable Glass Generation, by Sector
(excludes Seattle)

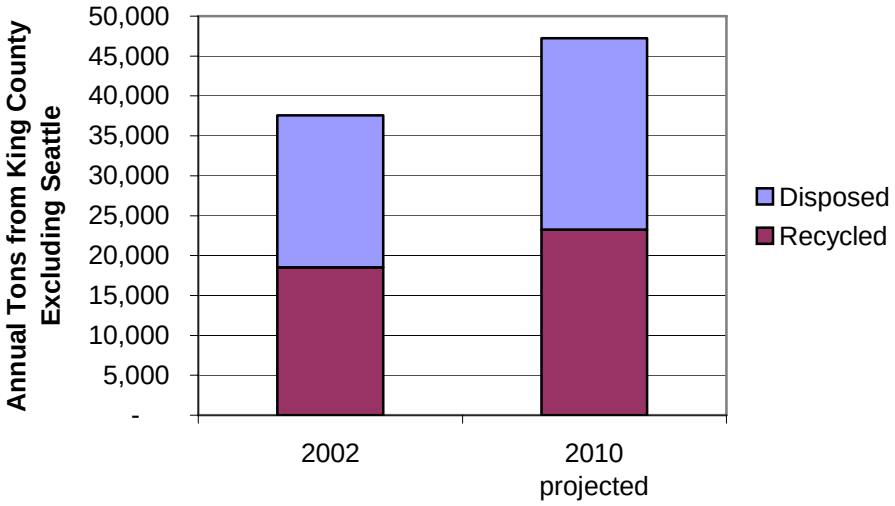
	Disposed	Recycled	Total Generated	Recycling Rate
Residential	9,733	14,128	23,861	59%
Commercial	7,892	3,534	11,426	31%
Self-Haul	1,432	865	2,297	38%
Total	19,057	18,527	37,584	49%

Projected Supply

Projections by King County Solid Waste Division staff predict, based on econometric modeling, that approximately 26% more waste will be generated in 2010 than was generated in 2002 (Rist, 2003). Accordingly, glass generation in King County is expected to grow over the coming years as population and economic activity increase. Based on King County's waste projections, we have projected a status quo future where glass generation increases but the recycling rate remains constant.

The following figure graphically displays this expected status quo increase. Note this projection does not take into account potential policy changes or economic incentives that could affect glass recycling, nor does it account for any further loss of glass' market share to plastic containers.

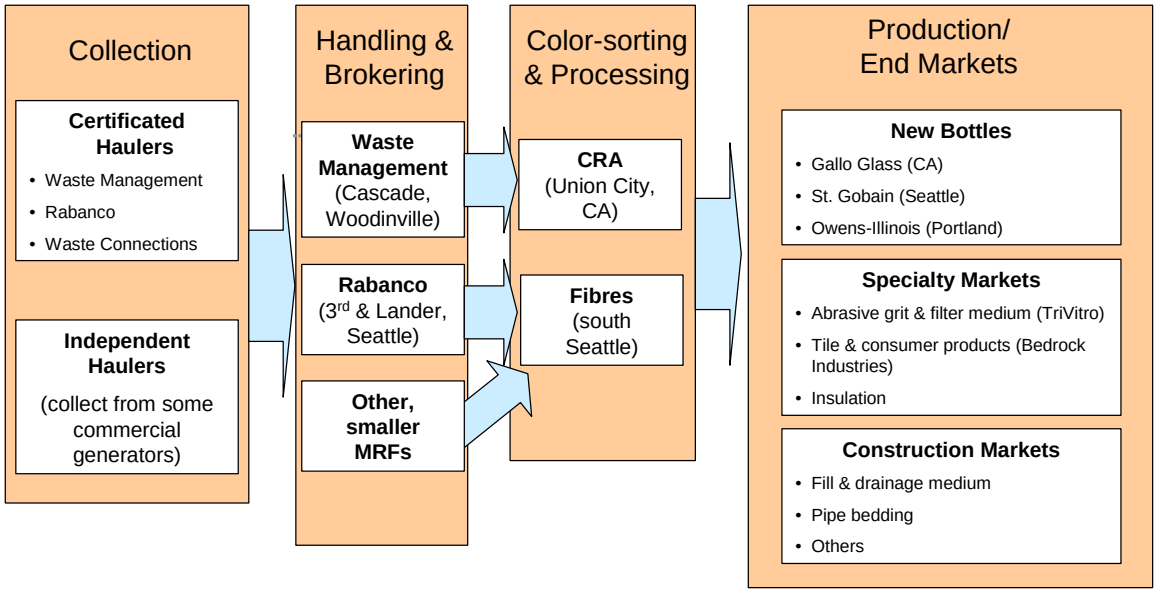
Figure 5-1. King County Glass Bottle and Container Generation: Current and Projected Status Quo
(excludes Seattle)



Processing & Infrastructure

Glass collected in King County generally takes one of two routes for processing – local sorting and processing at Fibres International's plant in south Seattle, or long-haul by railcar to a facility in the San Francisco Bay area. At either facility, glass is sorted by color as it passes over an optical device, and is then generally prepared for sale to bottle manufacturers. The following figure displays the supply chain for glass generated in King County.

Figure 5-2. Current Supply Chain for Recycled Glass Generated in King County



Following are more specific findings regarding the current collection and processing infrastructure for recycled glass in King County.

- **Most glass bottles and containers are collected by the franchised waste haulers, primarily Waste Management and Allied.** Residential curbside programs are the largest source of glass for recycling markets.
- **Only one local glass processor exists – Fibres International.** Fibres takes all glass from Seattle's curbside program and all glass collected by Rabanco/Allied (and its associated companies) in King County. Fibres processes the glass at its plant in the South Park neighborhood of south Seattle, where the company uses an optical sorter to sort the glass into green, brown, and clear.
- **Waste Management does not send its glass to Fibres – instead, it rail-hauls it to a plant in the San Francisco Bay area.** Waste Management's affiliate, CRA-Recycle America,[12] operates a glass recycling plant in Union City, California. The facility uses an optical sorter to sort glass to produce a mixed-color product favored by the wine industry, especially Gallo.
- **The effect of "single-stream" recycling on the marketability of glass remains uncertain.** Fibres reports that glass from single-stream collection is extremely difficult to process, as the increased quantities of paper and the greater fraction of the glass in smaller pieces decrease the

[12] CRA stands for Container Recycling Alliance.

effectiveness and efficiency of their sorting technology.[13] Observations of the two major local MRFs indicate that glass recovered from single-stream collection and sorting systems is significantly higher in contamination and has much smaller pieces of glass, compared to glass recovered from programs where glass is collected separately from other materials. This finding is consistent with national trends, but the marketing manager for Waste Management/Recycle America reports no problems with the glass coming out of the Woodinville facility, a single-stream MRF.

End Markets & Prices

Glass is a recyclable material for which truly "closed-loop" recycling is the norm. Glass bottles, when recycled, are typically turned back into glass bottles – a cycle that could continue indefinitely. Most of the glass collected in King County is remanufactured into bottles either in Seattle or in California's wine country.

- **Recycled glass bottles and containers from King County generally are made into new bottles.** An estimated 75% of the glass collected in King County is recycled into new bottles.
- **There are major bottle manufacturers in Seattle, Portland, and Modesto (California).** Glass processed by Fibres generally goes to Seattle's St. Gobain Containers, formerly Ball Glass, but some goes to Owens-Illinois in Portland. Glass collected by Waste Management and processed by CRA-Recycle America generally goes to Gallo Glass in Modesto, which makes bottles for the E & J Gallo Winery.
- **Using recycled glass in bottles saves manufacturers energy.** Using recycled glass saves energy as it melts at a lower temperature than sand and soda ash, the virgin materials used in glass manufacture.
- **Recycled content standards in California are reportedly still a major driver, but have been relaxed.** California recently relaxed its post-consumer recycled content law for producers that use primarily mixed-color cullet. Previously, all glass containers manufactured in California were required to contain at least 35% post-consumer recycled content. Now, producers that use primarily mixed-color cullet, including Gallo, must only use 25% post-consumer recycled content. This change was reportedly instituted to encourage bottle manufacturers to use recycled glass sourced from curbside recycling programs where glass is not color-separated.
- **Demand for glass in the bottling industry has remained relatively flat, while plastic is increasing its market share.** Growth in the bottling industry has come mostly in plastic, particularly in single-serve

[13] Although Fibres does not presently accept glass from any single-stream programs, the facility has run tests on the material and found it too contaminated to sort cost effectively.

PET containers. The use of plastic for beverage containers doubled between 1995 and 2002 (NAPCOR, 2003). Glass is still the material of choice for the alcohol industry, although the use of plastic beer bottles has increased, particularly at sporting events and other public venues. Growing popularity of flavored alcoholic beverages, the so-called "malternatives," and other high-end beverages is helping to offset the loss of glass' market share to plastic.

Recycled glass is not only made into new bottles, however. Some glass – particularly colored glass or crushed, unsorted glass referred to as "fines" – is also used in other, specialty applications.

- **A small percentage of recycled glass is made into abrasive grit and filter medium in King County.** TriVitro is a local, specialty market for the recycled glass collected in King County. TriVitro, unlike the bottling industry, also uses recycled plate glass in its applications.
- **A small percentage of recycled glass is made into tile and other consumer products.** Bedrock Industries is an award-winning Seattle company that uses recycled glass from curbside programs and other sources (such as artist studios) to make a wide variety of household, architectural, and garden products.
- **A small percentage of recycled glass enters the insulation and other markets.** CRA-Recycle America markets a small amount of glass to other markets, in addition to the Gallo Winery.

Finally, glass that is not marketable to any of the above, relatively high-value, markets (an estimated 25% of the glass) is generally stockpiled or sold for construction applications such as drainage medium or pipe bedding. However, sales of glass to these types of applications have decreased in the last few years.

- **Glass "fines" have limited markets.** The residual glass that remains after passing through the optical sorter (generally less than 25%) is generally too small to be sorted. These "fines" and other glass not suitable for bottles have been marketed as aggregate to the construction industry for use as fill or drainage medium. However, these markets have declined in the last five years, reportedly the result of declining construction activity. Glass is sometimes stockpiled for months until a buyer can be found. In some cases, the only way to move the fines is to pay someone to take them.
- **The only bottle manufacturer in King County – St. Gobain Containers – is concerned about cullet quality.** Quality concerns currently limit St. Gobain's ability to accept recycled glass cullet. The company reports that in theory it could use significantly more recycled glass in its operations. However, the company has recently had difficulty with the quality of the material coming from Fibres, including contamination from ceramics. St. Gobain reports that the recycled

content of its products averages 5% to 10%, but that this can vary from 0% for products with particularly sensitive specifications (e.g., some champagne bottles) to 40% for some dark-green wine bottles.

- **The decline in quality of locally sourced glass has reportedly occurred over the last few years.** St. Gobain reports that this decrease has occurred in the last two to three years, and the company speculates that the switch away from color-separated glass collection to commingled-color collection is one significant culprit. St. Gobain reports that it has had to scale back the recycled content of one of its products as a result of contamination. Contamination from ceramics is of particular concern, as its presence reduces the strength of the bottles, leading to failure. The decline in glass quality is apparently consistent with national trends, as reported by *Resource Recycling* (Powell, 2002b).
- **St. Gobain has stopped making amber beer bottles, thereby scaling back its use of recycled amber (brown) cullet.** St. Gobain still uses some amber cullet in a 75% clear, 25% amber mix it purchases from Fibres for use in its "dead-leaf green" colored bottles.
- **Green glass has limited local markets.** St. Gobain makes only one color of bottle – champagne green – in which they can use recycled green glass. This situation severely limits the local market for recycled green glass, and Fibres reports that they are currently stockpiling approximately 17,000 tons of green glass (many months' worth) in hopes of finding a buyer. However, markets for green glass do exist in California – due to the relative size of California's wine industry. While Waste Management's CRA-Recycle America facility in Union City has ready access to these markets, Fibres has had difficulty accessing cost-effective rail shipping to the California market.

Prices

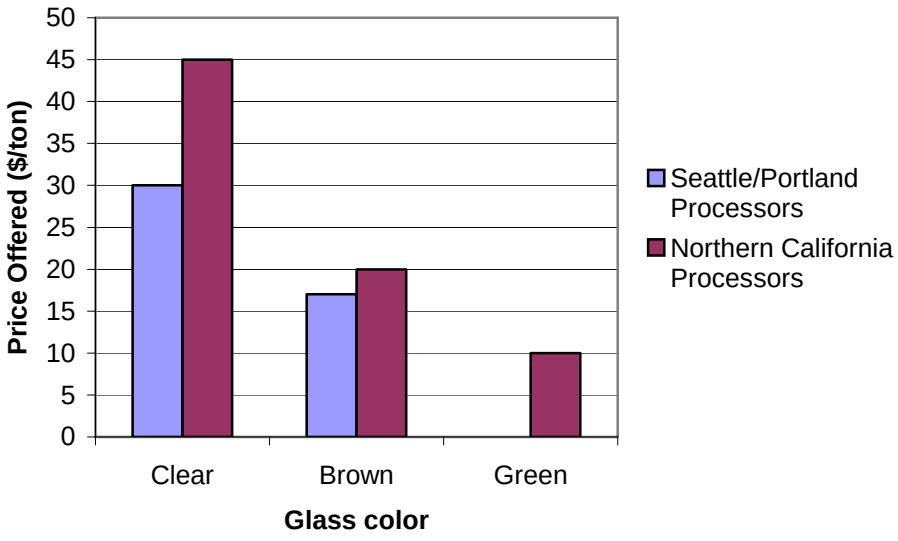
Glass commands the lowest prices of any major recyclable material picked up at the curb, with current Seattle prices ranging from $0 to $23/ton, depending on color. More specific points follow.

- **St. Gobain's price paid to Fibres has been stable.** St. Gobain reports that it has been paying about $58/ton for the glass cullet it receives from Fibres, regardless of color.
- **Fibres' price for source-separated clear glass has been stable, amber glass has been falling, and green glass has no paying market.** The City of Seattle reports that Fibres has offered an average price of $23/ton for clear glass since 1996. The price for amber glass was stable at $20/ton between 1996 and October 2001, when it dropped to an average of $17/ton, likely due to St. Gobain's reduction in beer bottle production (City of Seattle, 2003).

- **Fibres charges Allied/Rabanco to accept and process mixed, curbside glass.** Fibres charges Rabanco between $10 and $20/ton to accept and process glass from curbside recycling programs.
- **For glass manufacturers, recycled glass cullet is more expensive than virgin sand, but its total "batch" costs are competitive.** St. Gobain reports that it pays about twice as much for recycled cullet as it pays for sand. However, the price of other required materials (such as soda ash at $100/ton) and energy needs increases the total per-ton price of a batch of virgin feedstock to one comparable with the cost of recycled cullet. However, cost for virgin materials has been falling nationally in recent years, reducing the incentive to use recycled cullet (Powell, 2001).

Figure 5-3 displays the average prices for source-separated glass offered by Seattle/Portland versus northern California processors. Although processors are generally *paid* to accept and process mixed, curbside-collected glass, the prices below do indicate relative demand for glass by color and market. As the prices indicate, demand for clear glass is stronger than either brown or green glass, and demand in the northern California marketplace is notably stronger than in the Northwest.

Figure 5-3. Average Prices Paid by Processors for Source-Separated Glass
(Recycling Manager, 2004)



5.3 BARRIERS & OPPORTUNITIES

Glass recycling is not a growth market. There are numerous barriers to recycling glass, many of them local in nature. These barriers include the following:

- **The only local bottle manufacturer is highly concerned about the quality of recycled glass.** St. Gobain is displeased with the quality of glass it is currently receiving. The company and its supplier both blame

the decline of color-separated glass collection in favor of commingled collection as the source of the problem.

- **Local markets for green glass are extremely limited.** As has been the case for many years, local markets for green glass are small and unreliable. Markets in California are better due to the strong presence of bottle manufacturers that serve California's large wine industry.
- **Transportation logistics are a limiting factor for all but the largest companies.** Maintaining the capacity to access markets outside King County (particularly the California and Portland markets) is increasingly important for regional glass recyclers. Although large, vertically integrated companies like Waste Management can make the economics work, smaller, local processors have difficulty arranging cost-effective transportation to these markets.
- **Non-bottle markets (especially construction aggregate) are sagging, suggesting that a new approach is necessary.** Processors that handle and market glass from King County are having an increasingly difficult time moving glass fines as aggregate to construction applications. Possible new or increased end uses include glasphalt (use of recycled glass in asphalt production), road base, pipe bedding, and drainage fill. These uses would be relatively low-value compared to bottle-to-bottle recycling, but could fill an important need.

As is evident in the points above, glass cullet quality is a serious concern for local markets, and lack of markets for fines is a concern for both local and out-of-state glass processors. Unfortunately, there does not seem to be much current momentum to overcome barriers, either locally or in other areas. Perhaps the most promising market opportunity is to develop new high-value or high-volume markets to continue supporting glass recyclers and the relatively high recycling rates currently realized in King County.

- **Relatively high-value and high-volume markets that exist in other areas could be successful locally.** Fused glass products, in which mixed or sorted glass is melted and reformed into new products other than containers, may be an opportunity locally. A pilot project to make fused glass products such as pavers, tiles, and drainage pipe is now operating in North Carolina, and could serve as an example for local development (Powell, 2002a). Bedrock Industries of Seattle, which is already making some specialty products, could be a project partner.

5.4 PUBLIC SECTOR OPTIONS

Given the threatened state of glass recycling, King County may be faced with some significant decisions in the near future. If trends in other areas gain traction here, pressures may mount to discontinue (or significantly alter) glass recycling services. Our research into the local market conditions indicates further reason for concern: local processors are facing significant quality and marketing

challenges, and the local remanufacturer is highly dissatisfied with low-quality cullet. Most demand for glass is now in California, and Waste Management is rail-hauling all of its glass to a sorting plant in the San Francisco Bay area. One of the first opportunities for King County is to:

- **Conduct research to determine specifically where in the supply chain that glass quality is being degraded and to identify solutions.** Local glass recyclers are concerned that the trend from color-separated to commingled collection, followed by the recent switch to "single-stream" recycling has harmed the marketability of the material. Additionally, handling and processing practices at material recovery facilities (MRFs) should also be studied to determine best practices for recovering glass from single-stream collection programs.

Research into glass quality concerns may uncover significant challenges in recovering glass from single-stream collection programs. If such challenges cannot be overcome, the viability of local glass bottle remanufacture may be threatened, leaving only out-of-state markets. Yet the inherent logistical and economic challenges of shipping glass long distances may mean that only large, vertically integrated companies can access the California marketplace. Furthermore, even these companies may have difficulty justifying the cost and effort of glass recycling, given the potential challenges, largely due to contamination, of single-stream collection. Therefore, King County should:

- **Be prepared to conduct analyses to affirm or refute King County's commitment to glass recycling.** While presently little pressure exists to drop glass from local curbside recycling, King County may be faced with this issue in the future. King County could take a proactive approach and begin analyzing the environmental, social, and/or economic aspects of the various collection and marketing options now, involving local stakeholders.

Apart from these "big picture" opportunities, King County also has the ability to pursue other, on-the-ground actions to help the state of local glass recycling.

- **Facilitate access to rail services at a reasonable price.** The County should consider including space in a potential intermodal facility for recycler access to rail lines. Reasonably priced rail access could allow local recyclers access to a broader range of markets.
- **Renew education efforts on glass recycling.** The quality of glass streams has reportedly been slipping, and recyclers have called for renewed emphasis on glass recycling in government outreach literature. Particular emphasis should be placed on educating residents about contaminants, such as ceramics.
- **Consider providing market development assistance.** In particular, recyclers need assistance marketing their fines. The LinkUp program could aid in the testing, demonstration, and marketing of glass fines in the construction industry. One approach to marketing fines could be to

publicize their use as a recycled material eligible for credits under the Leadership in Energy and Environmental Design (LEED) system. Market development for green and amber/brown glass may also be needed if Fibres cannot work out cost-effective shipment to Portland and California markets. Additionally, King County could also help to identify and promote other potential higher-value uses, such as fused glass pavers, tiles, and other specialty products.

- **Consider using government purchasing power to stimulate the market.** King County and other local governments could specify that recycled glass products be used in upcoming infrastructure projects such as the new Brightwater wastewater treatment plant. Glass could be used as aggregate, glasphalt, road base, pipe bedding, drainage fill, or filter medium.

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Chapter 6
Metals

6.1 INTRODUCTION

A wide variety of metals are currently recycled through scrap dealers in Seattle and King County. These metals include appliances, automobiles, aluminum siding, industrial scrap, and other sources of residential, commercial, or industrial scrap metal.

The focus of this chapter, however, is on the types of metal packaging collected through municipal or commercially operated recyclables collection programs. Namely, these items are:

- Aluminum cans – beverage cans composed of aluminum only; and
- Steel food cans – tin-plated steel cans used as food containers (not including other bi-metals, paint cans, or other types of steel cans). In this chapter, tin-coated steel food cans will simply be referred to as *steel cans*.

These items have traditionally been core items in King County's (and the municipalities') recycling efforts, as they are readily recyclable and generally enjoy strong markets.

As our research indicates below, markets for these metals are currently holding strong, after recovering from setbacks in 1998-1999, but recovery rates may be sagging.

6.2 MARKET CONDITIONS

Trends & Key Variables Affecting Supply

Aluminum and steel cans have been collected by curbside recycling programs in King County for many years, and there are no notable changes in service to report. However, recycling rates for these items have been in recent flux. Recent developments include:

- **Recycling rates for steel cans have improved since 1996.** King County's recycling rate for steel food cans has increased from 36% in 1996 (Cascadia, 1998) to an estimated 51% in 2002. This increase is partly attributable to an education and outreach campaign conducted by King County in 1997. According to survey data collected by King County, an advertising effort helped raise awareness of the recyclability of steel cans from only 23% in 1996 to 86% in 1997 (King County Solid Waste Division, 1997).

- **Recycling rates for aluminum beverage cans have declined since 1996.** King County's recycling rate for aluminum cans has decreased from an estimated 68% in 1996 (Cascadia, 1998) to 52% in 2002. The decline in aluminum can recycling echoes a strong national trend that is possibly the result of more beverage consumption away from home and general decline in fervor for recycling (Gitlitz, 2003).
- **Businesses outperform residents in recycling aluminum cans, but underperform residents in recycling steel cans**. Analysis of available disposal and recycling data indicate that businesses recycle about 60% of their aluminum cans, whereas residents recycle an estimated 45%. Residents recycle 60% of their steel cans, whereas businesses recycle an estimated 22%.
- **A total of 3,800 tons of aluminum cans and 7,200 tons of steel cans were recycled from King County** (outside Seattle) in 2002, as determined by reviewing published King County recycling figures (King County, 2003) and conducting additional interviews with local recyclers.

Current Supply

The following table summarizes the quantities of aluminum and steel cans generated by King County's residential, commercial, and self-haul waste streams. As the table indicates, the total supply of these materials in King County (excluding Seattle) is roughly 14,000 tons.

Table 6-1. King County Metals Generation, by Sector
(excludes Seattle)

	Aluminum Cans				Steel Food Cans			
	Disposed	Recycled	Total Generated	Recycling Rate	Disposed	Recycled	Total Generated	Recycling Rate
Residential	1,403	1,133	2,536	45%	4,046	6,105	10,151	60%
Commercial	1,774	2,616	4,390	60%	2,495	691	3,186	22%
Self-Haul	355	69	424	16%	432	374	807	46%
Total	3,532	3,818	7,350	52%	6,973	7,170	14,143	51%

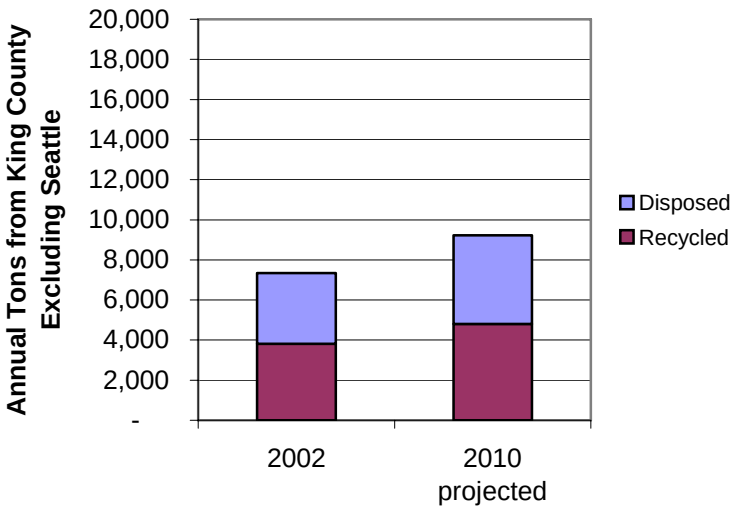
Projected Supply

Aluminum and steel can generation in King County is expected to grow over the coming years as population and economic activity increase. Based on econometric modeling conducted by King County Solid Waste Division, we have projected a status quo future where metal generation increases but the recycling rate remains constant. Projections by Solid Waste Division staff predict that approximately 26% more waste will be generated in 2010 than was generated in 2002 (Rist, 2003).

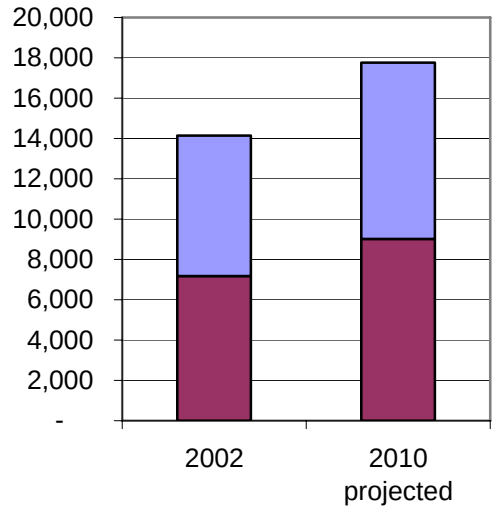
The following figures graphically display this expected increase. Note that this projection does not take into account potential policy changes such as disposal bans or other policies intended to increase metals recycling.

Figure 6-1. King County Metals Generation: Current and Projected Status Quo
(excludes Seattle)

Aluminum Cans



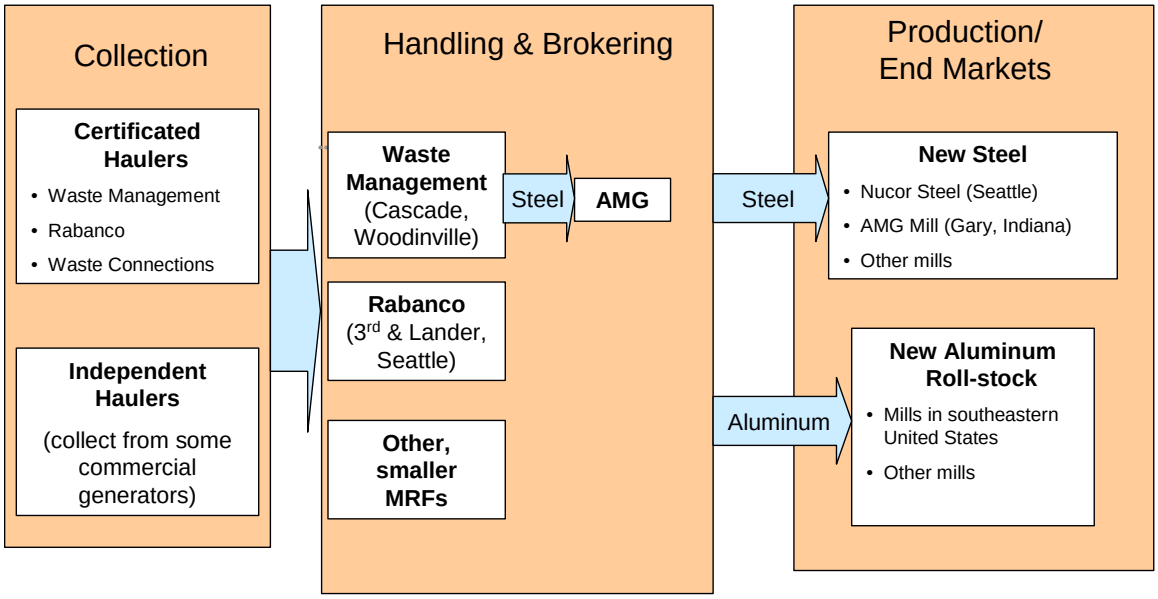
Steel Cans



Processing & Infrastructure

Due to the relatively high value and large quantities of metals, King County has a vibrant scrap metal industry with numerous buyers and sellers. But due to the large supply of scrap metal from appliances, automobiles, and industrial sources, aluminum and tin cans generally occupy a relatively small portion of the industry's business. In fact, in most cases aluminum and tin cans are sold directly from the MRF to the remanufacturer, without further processing. The following figure displays the supply chain for aluminum and tin cans generated in King County.

Figure 6-2. Current Supply Chain for Recycled Aluminum and Tin Cans Generated in King County



Following are more specific findings regarding the current collection and processing infrastructure for aluminum and tin cans collected from King County.

- **As with plastic and glass, the large haulers dominate collection of aluminum and steel cans.** However, one independent hauler reported collecting a significant quantity of aluminum cans (more than 2,000 tons) from King County's commercial sector. The high price of aluminum facilitates its recycling by a broader array of businesses.
- **Aluminum and steel cans are often sold directly to remanufacturers, rather than to intermediate processors.** Aluminum and steel cans can be baled and sold directly to end markets.[14] However, the presence of the tin coating on most steel cans limits their use by steel foundries.
- **De-tinning of steel cans adds value, but no de-tinning of steel cans occurs locally.** Too much tin in recycled steel makes it brittle. Proler International used to de-tin steel cans in the region, but this service was discontinued after Schnitzer Steel purchased the company several years ago. The economics of de-tinning have reportedly soured in recent years, as the processing costs have increased, largely due to rising energy prices (Force, 2004). While de-tinning improves the value of steel cans, the increased value is not currently sufficient to cover the costs of de-tinning. De-tinning is not essential for recycling, and King County's tinned cans from may be sold as far as Chicago. The only de-

[14] Scrap metal, however, requires further processing to achieve a consistent size and shape.

tinning mill operating in the U.S. is located in Maryland, a prohibitive distance for King County's steel cans to travel, given current economics.

- **Collectors and processors have little trouble selling their aluminum and steel cans.** Sellers can have access to a number of mills around the country as potential outlets, but a large quantity of material stays local at Nucor Steel. Rabanco/Allied sells its own steel and aluminum cans. Waste Management sells its own aluminum cans, but uses another firm, AMG Resources, to broker its tin-coated steel cans.

End Markets & Prices

Aluminum cans collected in King County are generally turned into new aluminum roll stock in the southeastern United States, although some may flow directly to other foundries as well. Most steel cans are remanufactured locally, at Nucor Steel in Seattle. The following points provide further detail.

Aluminum Cans

Despite the collapse of the region's aluminum industry, demand for aluminum cans is strong. Most material collected in King County is sold to buyers in the southeastern United States.

- **Essentially all aluminum cans collected in King County are marketed domestically.** Waste Management sells its aluminum cans to foundries in the southeastern United States, where it is made into roll stock for new aluminum cans. The cans themselves are usually made at other plants (Chambers, 2003). Rabanco/Allied also markets its aluminum cans domestically.
- **Due to aluminum's high price, foundries have little tolerance for contamination.** Some foundries are reportedly unhappy about the quantities of paper and plastic in the bales, and would like to see that all aluminum sorted at material recovery facilities (MRFs) go through a processor first to make sure it is clean. King County MRFs report that even though there is minimal contamination in the bales of aluminum, the high price paid by the foundries (about $1000/ton) means that contamination is more critical for aluminum than for most other materials.
- **In the future, used aluminum cans may flow to Asia.** A recyclables marketing manager for one of the large waste haulers operating in King County predicted that Asian markets would take interest in this material in the next few years. If experience from other recyclable materials is any guide, Asian firms may be able to offer higher prices, in part due to their lower labor costs.

Steel Cans

The domestic steel industry saw rough times in recent years, as Asian steel producers began flooding the U.S. market with low-cost steel in 1999. For a time, steel mills were charging to take recycled steel, as they sought to cut costs in an effort to compete with the new supply of low-cost steel. However, the situation has largely recovered, and demand for recycled steel is currently outpacing supply.

- **Demand is outpacing supply.** This condition is reportedly the result of several factors. For one, Chinese mills have come online and have been hungry for scrap steel, influencing the global market. Second, domestic supply of scrap metal has sagged in recent years, as appliance, automotive, and other manufacturing activities using steel have subsided. In addition, efficiency improvements in manufacturing operations may also lead to less scrap steel being generated, further limiting supply.
- **The vast majority (an estimated 90%) of steel cans collected in King County are still remanufactured locally.** Nucor Steel in south Seattle (formerly Birmingham Steel) is the primary destination for tin/steel cans collected from the region. However, as prices offered by Asian mills are increasing dramatically, more steel cans could start moving offshore in the future.
- **Steel cans are generally recycled into the construction market as rebar, and occasionally as I-beams** (Chambers, 2003). At Nucor Steel, 95% of the steel produced is rebar, but other markets also use cans in other applications, such as I-beams (Kale, 2003).
- **Few quality concerns exist for steel cans.** Nearly all contaminants – such as paper wrappers and remnant food – burn off during meltdown. One recycler reports that the cans often appear contaminated but that foundries have not complained. Bart Kale, Environmental Manager at Nucor Steel, still emphasizes that they prefer the cans to be clean and without paper, however. Although these contaminants do not impact the steel itself, they do increase the particulate emissions from the mill.
- **Nucor cannot increase its use of tin/steel cans.** For the first time ever, the plant in south Seattle is running at its permitted capacity for steel production (Kale, 2003). Furthermore, due to the presence of the tin coating on the steel cans, Nucor has reached the limit of the fraction of such cans it can accept. These factors limit the local remanufacturing of tin/steel cans.
- **Nucor's limit on tin/steel cans is not expected to dramatically affect the ability of recyclers to sell their cans.** Although local remanufacturing at Nucor has reached its limit, recyclers report that they could sell their cans to brokers or other, more distant mills.

The above points underscore the fact that the steel industry is a mature industry, which – although damaged by trade wars in 1999-2002 – is still a strong and stable market for the steel cans collected in King County.

Prices

Metals prices began dropping sharply in 1998 to 10-year lows in 1999, but in general have recovered to their strong 1997 levels. Prices for steel cans are greatly affected by the global marketplace – a linkage that was highlighted in the trade disputes concerning steel that began in late 1998.

- **Aluminum beverage cans are selling for $0.46 to $0.52/lb** ($920-$1040/ton). This range has been slowly increasing since 1999, when prices were in the $0.30 to $0.40/lb ($600-$800/ton) range. In 1995, aluminum beverage cans were commanding $0.70 to $0.75/lb ($1400-$1500/ton).
- **Prices for tin-plated steel cans crashed in late 1998 and early 1999.** Prices fell sharply from $30 to $40/ton to negative figures in the span of less than a year (City of Seattle, 2003). This crash was coincident with the flooding of low-cost Asian steel into U.S. markets, causing numerous U.S. steel mills to go bankrupt.
- **Since late 2002, prices for tin-plated steel cans have increased dramatically, reaching levels last seen in the mid-1990s** (City of Seattle, 2003). As of late 2003, prices had increased steadily to $40/ton or more. However, prices in early 2004 have risen dramatically, sometimes approaching $100/ton. These increases have been driven by China's new appetite for scrap metal as well as limited domestic supply of scrap metal. Although all cans collected in King County are reportedly still sold domestically, this situation could change in the near future.
- **Prices for scrap steel are influenced by the global market.** Dumping large quantities of offshore virgin steel into U.S. markets at low prices can cause scrap prices to drop dramatically (as occurred in 1998-1999). Conversely, booming offshore scrap mills can drive up domestic prices, as is currently the case. One metals broker reported that he expects the current high prices to continue for the foreseeable future.

Since tin-coated steel cans collected in King County are generally sold directly to remanufacturers (rather than passing through a processor), the type of price chart used in other chapters to compare processor to remanufacturer prices will not be included here.

6.3 BARRIERS & OPPORTUNITIES

Due to the mature state of the supply chain for recycled metals, no major barriers to recycling exists for either steel or aluminum cans. Markets are generally strong and mature, and quality is not a serious concern. However, there is a

potential barrier related to steel can de-tinning as well as an opportunity to recover more aluminum and steel.

- **Lack of local de-tinning capacity limits further growth of local steel can recycling.** Local remanufacturing capacity for tin-coated steel cans is finite, due to practical and permitting limitations at Nucor Steel. As a result, any increases in local supply will likely be diverted to other markets outside the region. Since markets are strong and there are many other potential buyers, this is not an immediate concern. However, it does suggest a possible opportunity to keep the cans in the local economy through reestablishment of local de-tinning capacity, process changes at Nucor Steel, or other means of increasing local remanufacturing.
- **The greatest opportunity is simply to increase supply.** Given the high demand and value of both aluminum and steel, there is a large opportunity to increase revenues by recovering more material. Recycling rates for aluminum and steel cans both hover at around 50%, suggesting considerable room for improvement.

6.4 PUBLIC SECTOR OPTIONS

Given the lack of barriers to metals recycling, there is no immediate need for public sector action. However, given the quantities of aluminum and steel cans still being disposed, local governments do have the opportunity to increase recycling rates and support the recycling economy though the following actions.

- **Renew education efforts to increase supply.** As identified above, the greatest opportunity in aluminum and tin/steel can recycling is simply to increase supply. Most notably, the recycling rate for aluminum cans seems to be slipping, indicating a change in attitude or consumer behavior in regards to these items.
- **Consider disposal bans or mandatory recycling for aluminum and steel cans.** Bans or mandatory recycling could be an effective means to capture the high inherent value in aluminum and steel cans. Given the high value and demand for these items, markets could easily absorb any increased material.
- **Investigate the costs, benefits, and potential environmental impacts of de-tinning steel cans.** King County and other governments consider providing incentives for a local de-tinning facility if found to be in the public interest.

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Chapter 7
Organics

7.1 INTRODUCTION

This study characterizes current and future supplies of organic materials as well as end markets for organic products in King County. This study builds on previous market research, including the state Department of Ecology's Beyond Waste *Establishing the Organics Cycle in Washington State* as well as a market assessment conducted as part of King County's *Organic Materials Management Feasibility Study*.[15] The current market study seeks to update key components of these prior efforts. Much of the information in this study is based on interviews with local processors, industry experts, and government representatives.

The organics marketplace differs from other recycling markets covered in this study due to its relatively localized nature. Because transportation costs are high relative to material value, organics from the municipal solid waste (MSW) stream are currently not exported from the Puget Sound region. Processors may on occasion deliver finished product as far south as Olympia or as far north as Skagit County, but most organic material is sold locally – that is, within King, Snohomish, and Pierce counties. Accordingly, local processors, as well as local government policies and programs, have significant influence on this market.

For the purposes of this report, five types of organics are defined as follows.[16]

- **Food waste** – food wastes and scraps, including meat and bone, vegetable peelings, fruit rinds, and similar materials;[17]
- **Yard waste** – leaves, grass clippings, garden wastes, as well as brush and branches under four inches in diameter;
- **Animal waste** – livestock manure;

[15] Cascadia Consulting Group et al., 2000a, *Organic Materials Management Feasibility Study, Volume Three: Market Assessment*, prepared for King County Department of Natural Resources, June 2000. Cascadia Consulting Group et al., 2003, *Establishing the Organics Cycle in Washington State: Beyond Waste Consultant Team Issue Paper #5*, prepared for the Washington State Department of Ecology, March 26, 2003.

[16] Additionally, WAC 173-350-100 of the Solid Waste Handling Standards (WAC Chapter 173-350) defines the following organic feedstock types for permitting purposes: "Type 1 feedstocks" means source-separated yard and garden wastes, wood wastes, agricultural crop residues, wax-coated cardboard, pre-consumer vegetative food wastes, other similar source-separated materials; "Type 2 feedstocks" means manure and bedding from herbivorous animals; "Type 3 feedstocks" means meat and post-consumer source-separated food wastes or other similar source-separated materials; and "Type 4 feedstocks" means mixed municipal solid wastes, post-collection separated or processed solid wastes, industrial solid wastes, industrial biological treatment sludges, or other similar compostable materials.

[17] For permitting purposes, WAC Chapter 173-350 divides food waste into pre-consumer vegetative food wastes (Type 1 feedstocks) and meat and post-consumer food waste wastes (Type 3 feedstocks).

- **Biosolids** – nutrient-rich organic materials resulting from the treatment of sewage sludge, as defined by the U.S. Environmental Protection Agency;[18] and
- **Compostable/food-soiled paper** – paper towels, paper plates, waxed paper, tissues, and other papers that were soiled with food during use, such as pizza box inserts.

The scope of this study focuses primarily on yard and food waste, with a secondary consideration of compostable food-soiled paper. We do not examine the markets for land-clearing debris, except for those materials that are delivered as green waste to transfer stations and organics processing facilities. Chapter 11 covers urban wood materials. This study does not cover markets for animal waste and biosolids, except for comparison purposes.

The products examined in this chapter include the following:

- **Compost** – decomposed organic material produced when microorganisms break down organic residue, such as recycled plant waste or other organic matter; compost can be used as a soil amendment to add nutrients and improve soil health.
- **Compost tea** – liquid "brewed" from compost containing the beneficial nutrients and microbes found in compost; and
- **Topsoil/Soil blends** – topsoil is the nutrient-rich top layer of soil, composed of a mixture of organic and mineral content; soil blends sold by landscapers often are designed to replicate this composition and may use compost to provide organic matter.

In developing this market assessment, Cascadia obtained information on organics markets from four types of sources. First, we reviewed previous market research. Second, we conducted telephone interviews with the four major local compost producers. Third, we interviewed industry experts from government agencies, a landscaping company, industry associations, and other operators. Additionally, we conducted a literature review to address issues that arose from interviews and to gather further information.

7.2 MARKET CONDITIONS

Markets for organics collected from the waste stream have grown steadily over the last decade, with an increase in supply, a relatively dependable infrastructure for collection and processing now in place, and increased end user acceptance of compost as a soil amendment product. End markets for yard waste are fairly stable at this time. However, end markets for post-consumer food waste and food-soiled paper are only now being developed, as curbside and commercial collection programs for these materials are in their infancy in the region.

[18] U.S. Environmental Protection Agency, http://www.epa.gov/ebtpages/watewastewbiosolids.html.

Key findings on supply, infrastructure, and end markets for organics in King County are presented below.

Trends & Key Variables Affecting Supply

- **The vast majority of organic material recycled from King County is yard waste from residential curbside programs.** Of the over 110,000 tons of yard waste recycled from King County in 2002, over 100,000 tons were collected from residential curbside programs.
- **The supply of yard waste from the residential sector is close to its maximum, with a recovery rate estimated at 87%.** This high recovery rate is largely the result of a disposal ban and convenient curbside collection service.
- **However, the commercial and self-haul sectors are still disposing significant quantities of yard waste.** Approximately 32,000 tons of yard debris are being disposed from these sources.
- **Collection of food waste is increasing, though it remains in its early stages.** Limited food waste recovery has been underway for some time, though the practice is not yet widespread. Since 1995, for example, about 10,000 tons of *pre-consumer* vegetative food scraps and soiled/waxed-corrugated cardboard have been collected each year within Seattle from some grocery stores and restaurants and composted at Cedar Grove (Uhlar-Heffner, 2003). Collection of *post-consumer food waste* has long been touted as the next frontier for recycling. This vision is now starting to become a reality, with pilot curbside collection programs in progress, permanent collection planned in several communities, and some collection from the commercial sector, including pilot on-site composting programs.[19] For example, the following efforts are underway in the region:
    - Issaquah, Kirkland, Lake Forest Park, and Redmond participated in a pilot program for collecting food waste from residents during 2002 and 2003.
    - Bellevue, Kirkland, and Redmond recently began accepting food waste and food-soiled paper along with their curbside yard waste collection from residents citywide.
    - Several commercial food waste collection pilot projects are taking place in King County in 2004, and the County may also add residential collection of food waste in some unincorporated areas.

[19] Facilities permitted to compost yard and garden waste are also permitted to accept pre-consumer vegetative food waste. To expand their permits to accept meat and other post-consumer food wastes (WAC Type 3 feedstocks), facilities must undergo an extensive process due to concerns about human pathogens.

Outside the region, several cities, including San Francisco and Portland, have established food waste collection, though the amount collected relative to total generation remains quite low.

- **Food-soiled paper represents another key source of organic material from the municipal solid waste stream.** About 50,000 tons of compostable paper is currently disposed in King County – about half from the residential sector and half from the commercial sector. Food-soiled paper can be included in mixed yard and food waste collection containers.
- **Although not completely resolved, clopyralid contamination of compost appears under control.** In 1999, Department of Agriculture investigators found that clopyralid – a persistent chemical found in many herbicides designed to control weeds and brush – damaged certain vegetables and landscape plants. In 2001, compost contaminated with clopyralid was detected in the compost at several composting facilities in Washington, prompting a minor crisis in the composting industry. Processors interviewed for this study consider the clopyralid problem to be under control for now, and most now test their materials for the presence of this herbicide. Although the Washington State Department of Agriculture (WSDA) banned clopyralid from use on residential and commercial lawns in 2002, the chemical is still allowed for some agricultural uses in Washington, and it has not been banned nationwide or in Canada (WSDA, 2004). Accordingly, the potential remains for this herbicide to enter the organics supply chain in detectable amounts in King County, and ongoing testing may be required to ensure that clopyralid does not reemerge as a significant problem.

Current Supply

Table 7-1 summarizes the quantities of food and yard waste generated by King County's residential, commercial, and self-haul sectors and recovered through public and private collection programs in 2002. A total of nearly 400,000 tons of organics were generated in King County, excluding Seattle, with about 110,000 tons recovered, for a 28% recovery rate. As shown in the table, King County's organics waste stream includes the following substreams:

- Estimated commercial sector recovery of yard waste is 48%, compared with 87% for the residential sector. Over 9,000 tons of yard debris are still disposed by the commercial sector.
- Little yard waste is recovered from the self-haul stream: only 5% is recycled (1,200 tons), while 23,000 tons are disposed.
- Nearly 190,000 tons of food waste and over 50,000 tons of compostable paper are currently disposed in King County outside Seattle. This supply offers potential for a dramatic expansion of the organics market, if the material can be economically and safely recovered from the waste stream.

- King County generates and recovers a larger share (almost two-thirds) of the organics waste stream – including yard waste, food waste, and compostable paper – than Seattle. In 2002, King County recycled about 110,000 tons of yard waste, compared with 53,000 for Seattle.

Table 7-1. King County Organics Generation, by Sector, 2002[20]

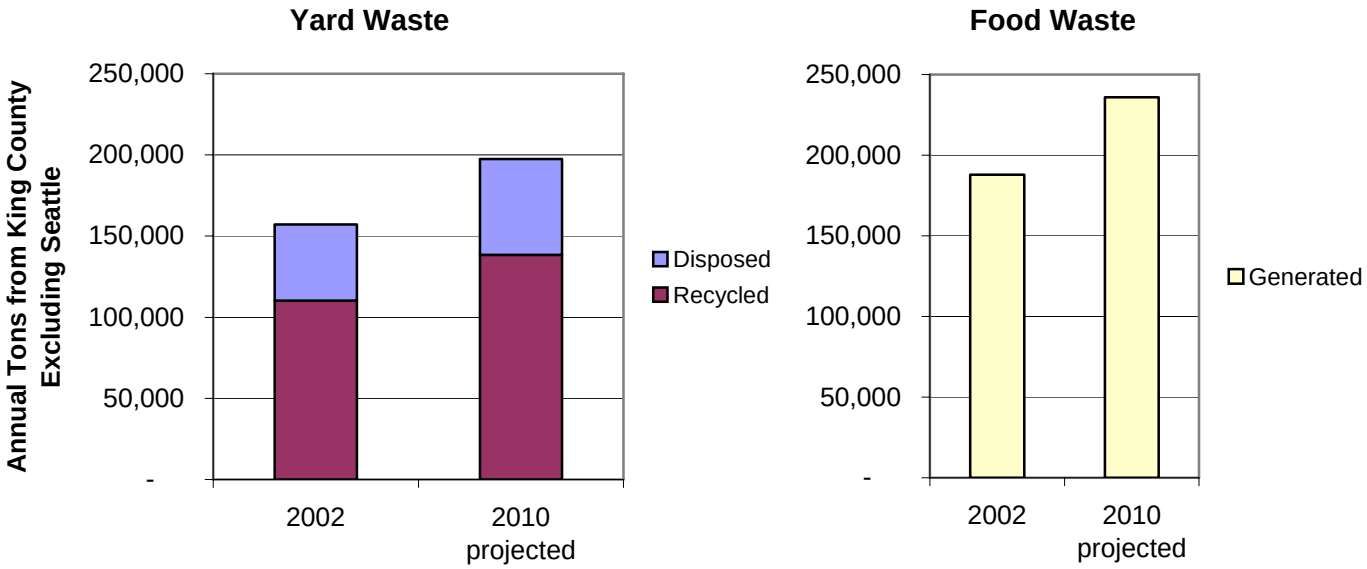
	King County (excluding Seattle)				King County (including Seattle)			
	Disposed	Recycled (Composted)	Total Generated	Recycling Rate	Disposed	Recycled (Composted)	Total Generated	Recycling Rate
Food Waste	**187,824**	**0**	**187,824**	**0%**	**290,300**	**12,985**	**303,285**	**4%**
Residential	105,176	0	105,176	0%	152,252	0	152,252	0%
Commercial	73,402	0	73,402	0%	127,800	12,985	140,785	9%
Self-haul	9,247	0	9,247	0%	10,248	0	10,248	0%
Yard Waste	**47,127**	**110,133**	**157,260**	**70%**	**62,136**	**163,444**	**225,580**	**72%**
Residential	14,886	100,153	115,039	87%	18,509	134,656	153,165	88%
Commercial	9,349	8,737	18,086	48%	14,439	13,179	27,618	48%
Self-haul	22,892	1,243	24,135	5%	29,188	15,609	44,797	35%
Compostable Paper	**52,054**	**0**	**52,054**	**0%**	**72,783**	**0**	**72,783**	**0%**
Residential	24,248	0	24,248	0%	34,193	0	34,193	0%
Commercial	25,362	0	25,362	0%	35,993	0	35,993	0%
Self-haul	2,444	0	2,444	0%	2,597	0	2,597	0%
Total Organics	**287,006**	**110,133**	**397,139**	**28%**	**425,219**	**176,429**	**601,648**	**29%**
Residential	144,310	100,153	244,463	41%	204,953	134,656	339,609	40%
Commercial	108,112	8,737	116,849	7%	178,232	26,164	204,396	13%
Self-haul	34,584	1,243	35,827	3%	42,034	15,609	57,643	27%

Projected Supply

As population and economic activity in King County grow, organics generation is expected to increase as well. Projections based on econometric modeling conducted by the King County Solid Waste Division predict that the county will generate approximately 26% more waste in 2010 than it generated in 2002 (Rist, 2003). Accordingly, the generation of food waste, yard waste, and compostable paper is predicted to increase from roughly 397,000 tons in 2002 (as displayed in the above table) to an estimated 499,000 tons in 2010, or an increase of over 100,000 tons.

[20] Although a small amount of food waste was collected in the residential pilot projects in 2002, these figures are not included in the overall King County Solid Waste Division data summary. Table data sources: Cascadia Consulting Group, 2003a; Cascadia Consulting Group, 2002; Bagby, 2003; City of Seattle, 2003; Cascadia Consulting Group, 2004; King County, 2003a; and Humphreys, 2003.

Figure 7-1. King County Food & Yard Waste Generation: Current and Projected Baseline
(excludes Seattle)



Future organics recovery levels are more difficult to project. For yard waste, with a continuation of the current status quo recovery levels, an additional 30,000 tons can be expected over the next six years, for a total of 140,000 tons by 2010. More aggressive policies could recover an additional 27,000 tons of yard waste, if commercial and self-haul sector recovery rates were increased to the level of recovery from the residential sector.

Given that collection programs are only beginning for post-consumer food waste and food-soiled paper, it is problematic to estimate recovery and supply levels for these materials with any certainty. However, the two endpoints for possible quantities are as follows:

- **Aggressive recovery could capture nearly 90,000 tons of food waste and food-soiled paper per year**. In this ambitious scenario, implementation of food and compostable paper programs would be widespread, with the entire county served by 2010. Basic assumptions for this scenario include household participation of 70% and efficiency of material recovered from each house of 70%. Commercial sector recovery is assumed to be nearly 100% from 25% of the businesses.
- **Limited recovery will capture roughly 18,000 tons of food waste and compostable paper per year.** If food waste collection programs target only about 20% of King County residents, as expected in 2004, an additional 18,000 tons of food waste and compostable paper could be collected. Assumptions for this scenario are identical to those above except that the programs are assumed to target only 20% of King County residents, as opposed to 100%.

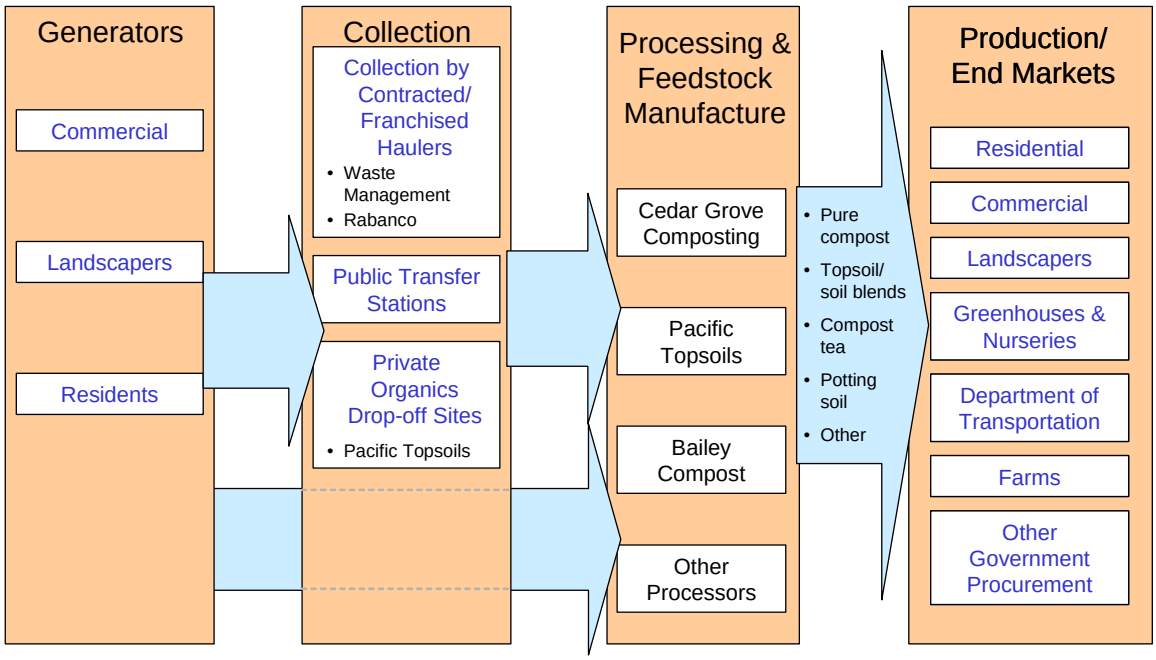
These estimates provide a range of possible recovery levels. As noted, it is premature to define even a baseline supply estimate for food waste recovery. These scenarios do show the potential, however, for additional supply and the corresponding need to ensure adequate processing and end markets, if these policy-driven supply levels were to be achieved.

Supply Chain for Organics

Figure 7-2 presents a graphic depiction of the supply chain for organics collected from the municipal solid waste stream in King County. As shown, most recovered organic materials take the following path from generators to end markets:

- **Commercial establishments, landscapers, and residents are the primary generators of compostable yard waste, food waste, and paper.** As noted above, nearly 400,000 tons were generated in 2002.
- **Franchised haulers collect organic materials, or generators self-haul them to public and private facilities.** Contracted or franchised haulers, such as Waste Management and Allied/Rabanco, collect much of these materials for recovery. In addition, generators also take organics to transfer stations or private drop-sites, such as those operated by Pacific Topsoils, for recovery.
- **Processors make the recovered organics into compost, soil blends, and other mulch products.** This processing occurs at either large regional facilities – such as those operated by Cedar Grove Composting, Bailey Farms, and Pacific Topsoils – or at smaller sites often operated by landscapers. Most of the material collected in King County goes to Cedar Grove for processing.
- **Residents, landscapers, nurseries, government agencies, and others purchase the finished compost and other organic products.** Finished products are sold in bulk or bagged form to a wide variety of end markets.

Figure 7-2. Current Flows of Organic Waste Generated in King County[21]



This supply chain has developed over the last 15 years primarily to handle the supply yielded from curbside yard waste collection and to meet growing demand from end users for organic soil amendment products. The following sections highlight key dynamics and trends for organic materials at the processing and end markets stages in this chain.

Processing

Three main companies serve the regional organics processing market in King County, with one firm – Cedar Grove – dominating the marketplace. Cedar Grove Composting, Pacific Topsoils, and Bailey Compost handle all of the curbside-collected yard waste and most of the self-hauled yard debris from King County. In addition, a handful of generators including farmers, landscapers, and golf courses reportedly process their own organics (Bartlett, 2003). LRI, based in Pierce County, is another large regional processor, but currently little, if any, organics collected from King County are taken to LRI.

Table 7-2 summarizes the self-reported permitted capacities and throughput of these processors in 2002. As shown, the region contains an approximate total of 485,000 tons of capacity, including 360,000 tons in King and Snohomish counties. Cedar Grove represents 73% share of the 2002 King & Snohomish throughput, while Pacific Topsoils processes 21%, and Bailey Farms handles 6%.

[21] Other than the portion processed at organics facilities, land-clearing waste is not included in our study. It is frequently ground on site or is taken to wood processors.

Table 7-2. Reported Capacities at Local Organics Processing Facilities[22]

Company	Facility	Permitted Capacity (tons)	Yard and Food Waste Processing in 2002 (tons)	Expected Near-term Excess Capacity
Pacific Topsoils	Mill Creek/Maltby[1]	54,000	54,764	0
Cedar Grove	Maple Valley/Everett[2]	276,000	189,166	86,834
Bailey Farms	Snohomish[3]	30,000	16,000	0
Subtotal: King and Snohomish Counties		*360,000*	*259,930*	*86,834*
LRI	Puyallup	93,000	45,225	47,775
LRI	Pierce County Facility	32,000	21,582	10,418
Subtotal: Pierce County		*125,000*	*66,807*	*58,193*
Totals		**485,000**	**326,737**	**145,027**

1. Pacific Topsoils plans to move their operation entirely to the Maltby location this year (Ruppert, 2004). The 2002 throughput is a reflection of the slightly larger permitted capacity at the Mill Creek site.
2. Since Cedar Grove now owns Soos Creek Organics, this table includes 2002 quantity data from Soos Creek in the Cedar Grove totals. (In 2003, severe odor problems forced Soos Creek to cease its operations in Covington, and Cedar Grove subsequently purchased the company's assets.)
3. Although Bailey Farms is only operating at about 50% capacity according to their permit, the site is reportedly limited by pad size and equipment and therefore is already operating at capacity (Bailey, 2004).

Cedar Grove is expected to remain the dominant force in the processing industry for the foreseeable future. Cedar Grove Composting has positioned itself as the major player processing organics in the region for some time to come. Recent developments enhancing Cedar Grove's position include the following steps:

- **Cedar Grove purchased the assets of Soos Creek Organics** after severe, ongoing odor problems forced Soos Creek to cease its operations in 2003. Cedar Grove now accepts clean yard waste from self-haulers and sells bulk compost at Soos Creek's former Covington location.
- **The company has gained the exclusive rights to use of the Gore Cover system in the Northwest region.** This system reduces costs, increases efficiencies, virtually eliminates odor from composting operation, and decreases stormwater impacts. Their acquisition of the system is intended to provide Cedar Grove with a strong competitive advantage in bidding for organics processing contracts. The Gore Cover system is well suited to processing food waste, again providing Cedar Grove with an advantage in this new market segment.

[22] Excess capacity for LRI is based on published figures, which representatives from the company did not verify.

- **Cedar Grove plans to open a new composting facility in Everett in 2004.** The site will initially be permitted to handle 81,000 tons of organics annually, and eventually Cedar Grove hopes to increase the permitted capacity to 123,000 tons annually. This new facility will not only allow the company to expand its service in Snohomish County, but it will also free up more capacity in King County as compost production shifts to the new location. In addition, the new facility should reduce transportation costs associated with transporting organic feedstock to the processing facility and moving finished products to market.

Barriers to entry for new large-scale processing facilities are high, making new entrants into this industry unlikely. Urban development, environmental and health standards, and other restrictions make it extremely difficult to site and permit a new large-scale processing facility anywhere in King County.

- Locating a new facility is challenging because of neighborhood opposition associated with concerns about odor and truck traffic. Soos Creek offers a case study in the challenges of operating compost facilities near population centers. After years of ongoing odor complaints from neighbors, the company found it cost-prohibitive to invest in the systems needed to manage odors and renew their operating permit.
- Large-scale composting facilities are required to comply with a host of minimal functional standards. In November 2003, Public Health – Seattle & King County approved new Washington State rules (Chapter 173-350 WAC) governing solid waste handling. These rules updated previous requirements to provide a consistent statewide set of regulations, including testing for heavy metals and pH and strict management of leachate and stormwater runoff.

The consolidation of the processing industry has potential long-term implications for regional compost markets and policymakers. The consequences of this industry concentration are uncertain. One industry expert speculated that tip fees charged by processors could rise over time as a consequence of less competition (Gage, 2004). Limited competition may also affect the development of food waste composting, with the possibility that only one firm – Cedar Grove – is in position to process food waste and compostable paper collected in the region. Cedar Grove's position will clearly give them pricing power and other types of influence over haulers and, indirectly, programs in suburban cities and unincorporated areas of King County.

Permitted processing capacity currently exceeds throughput, providing the basis for growth without building new or expanding current facilities. As shown above, Table 7-2 reveals that capacity in King and Snohomish counties currently exceeds production by nearly 87,000 tons, meaning that the industry is utilizing about 72% of its total current capacity. It is unclear how quickly Cedar Grove's new site in Snohomish County will reach capacity, but it appears that the facility operators have the ability to absorb additional supply associated with increased collection of yard waste and start-up of food waste collection

programs. Bailey Farms reports, however, that they are unlikely to be able to produce at permitted capacity due to equipment constraints.

Long-hauling of organics out of the region for processing is not anticipated, but it may be feasible at some point in the future. Currently none of the organic material collected in King County is known to be shipped out of the region for processing. Some other cities and counties in the Northwest, however, do contract with distant facilities. For example, both the City of Portland and Spokane County long-haul their organic waste to Three-mile Canyon Farms in eastern Oregon.

Capabilities and technologies exist to process food waste, but permitting and operating issues remain.

- **Composting of mixed yard and post-consumer food waste appears to be feasible.** The limited experience of processors handling food and yard waste is reported to be successful, with minimal processing complications associated with the addition of food waste to the mix. With excess composting processing capacity in the region, the ability of processors to handle increased quantities of food waste is considered adequate, particularly now that Cedar Grove obtained its permit to handle post-consumer food waste, starting in March 2004.
- **Both Cedar Grove and LRI now have permits to process post-consumer food waste**. In March 2004, Cedar Grove received a Health Department permit to accept all residential source-separated food wastes, allowing the company to move forward with food waste composting using its Gore Cover system technology.[23] LRI in Pierce County has a similar permit. Pacific Topsoils, however, is currently handling post-consumer food waste through permission from local agencies, rather than a permit.
- **Human pathogen issues must be addressed when post-consumer food waste is added to the composting stream.** According to Washington Administrative Code section 173-350-220, composters that process post-consumer food waste must have a pathogen reduction plan that includes testing for fecal coliform and salmonella pathogens at least quarterly. These pathogens are considered to be "indicator organisms," meaning that their absence suggests that the material also remains free of other human pathogens (Salter, 2003). Another pathogen concern associated with food waste composting is bovine spongiform encephalopathy, known as BSE or mad cow disease. However, a recent report completed for the City of Portland suggests that the likelihood of BSE being transmitted through food residuals in compost is "remote" (Crockett, 2003). Although this study was completed prior to the discovery of BSE in Washington in December 2003, it was based in part

[23] Cedar Grove is in the process of obtaining a permit to accept Type 3 feedstocks, which consist of meat and post-consumer source-separated food wastes or other similar source-separated materials.

on a study conducted in the United Kingdom, which has much more extensive experience with BSE.

- **Updating processing systems may be required to obtain a permit to process post-consumer food waste.** The compost operation must take into account odor and leachate issues associated with processing food waste. Depending on the location of the facility and its proximity to residents, an indoor tipping floor would likely be required to receive the material. Only Cedar Grove and LRI currently have an enclosure suitable for accepting mixed food and yard waste. Pacific Topsoils, for instance, will not be able to use their current static pile method and will likely need to invest in a new process, such as in a larger pad to accommodate more, smaller windrows (Ruppert, 2004). They also do not have an indoor tipping floor, although a company representative noted they may have ways to avoid needing one.
- **Anaerobic digesters may also emerge as a viable technology for food and compostable paper processing in the future, although costs are high.** A 2002 Seattle Public Utilities study examined the feasibility of anaerobic digestion of residential and commercial food waste. This study found that the processing costs were higher than those for composting: between $53 and $60 per ton for commercial waste and between $60 and $66 per ton for residential food waste (Uhlar-Heffner, 2003). Variables in this study included the unpredictability of revenues from methane gas energy recovery.

Changes in solid waste regulations and minimum functional standards are likely to lead to an increase in small-scale composting activities. Exemptions included in the solid waste handling rules regarding material volume, end use, and generator type were designed to facilitate composting for certain generators (WAC 173-350-220). For instance, composting of food waste generated on-site is permitted in containers that total less than ten cubic yards. The new rules also include exemptions for farms, such as allowing composting of organics generated both on-site and off-site, provided that the finished compost is used on-site. This flexibility for small-scale composting operations should result in an increase in such activity in the region.

7.3 END MARKETS & PRICES

The organic material collected and processed in King County is transformed into a variety of different end products, from pure compost, to soil blends, to compost tea. These materials are sold into many different markets, including home gardeners, landscapers, nurseries, and government agencies. This section provides an overview of these end markets, highlighting trends and developments, particularly their status since the completion of the King County's 2000 *Organic Materials Management Feasibility Study*.

Table 7-3 lists the products and prices charged by Cedar Grove and Pacific Topsoils and Sawdust Supply, a distributor of organic products in King County. As shown, pure compost is priced less than soil mixes, bark, and most specialty mulches. Compost from Cedar Grove, which retails at $16.00 per cubic yard, is priced competitively with GroCo from Sawdust Supply, a similar product made from biosolids and sawdust, priced at $18.45 per cubic yard. The table also tracks price changes since 1999. Pure compost from Cedar Grove has risen 2.8% on an annual basis. This increase compares to the rise in the Consumer Price Index, which has averaged 2.4% from 1999 to 2003.

Table 7-3. Local Organics Product Prices by Company

Cedar Grove *Retail*	*cu. yd.* *1999*	*cu. yd.* *2004*	*Annualized Cost Increase*
Pure Compost	$13.95	$16.00	2.8%
Two-way Topsoil	$15.95	$18.00	2.4%
Potting Soil	$28.00	$30.00	1.4%
Medium Fine Bark	$15.00	$17.00	2.5%
Fine Bark	$17.00	$19.00	2.2%
Wholesale			
Pure Compost	$11.50	$13.00	2.5%
Two-way Topsoil	$13.50	$15.00	2.1%
Potting Soil	$26.00	$28.00	1.5%
Medium Fine Bark	$13.00	$15.00	2.9%
Pacific Topsoils *Retail*	*1999*	*2004*	*Annualized Cost Increase*
5-Way Mix Topsoil	$13.50	$16.50	4.1%
3-Way Mix Topsoil	$14.50	$17.50	3.8%
Enviro-mix	$16.50	$20.50	4.4%
Special Garden Mix	$14.50	$20.00	6.6%
Fine Bark	$16.50	$21.50	5.4%
Medium Fine Bark	$13.50	$18.75	6.8%
Cedar Playchips	$17.75	$25.75	7.7%
Pacific Garden Mulch & Screened Comp Mulch	$15.50	$20.50	5.8%

Sawdust Supply *Retail*	*cu. yd.* *1999*	*cu. yd.* *2004*	*Annualized Cost Increase*
Bark	$15.20	$18.95	4.5%
Nuggett	$24.95	$29.20	3.2%
GroCo	$13.95	$18.45	5.8%
SteerCo	$16.45	$19.70	3.7%
Cedar Grove	$20.95	$27.45	5.6%
Planting Mix	$18.95	$22.45	3.4%
Topsoil	$18.95	$22.45	3.4%
Playchips	$19.95	$24.70	4.4%
Sawdust/Fir	$7.00	$10.00	7.4%
Sawdust/Alder	$16.45	$19.70	3.7%
Shavings/Fir (sold by the bale)	$7.00	$7.50	1.4%
Shavings/Cedar (sold by the bale)	$7.00	$7.50	1.4%

Composted organics from the municipal solid waste stream compete with many other soil amendment products and to some extent with fertilizer products as well. Competing soil amendment products include mushroom compost, composted steer or chicken manure, biosolids compost, and specialty mulches.

The market assessment conducted for King County's *Organic Materials Management Feasibility Study* in 2000 identified six high-potential end markets for compost and other processed organics: 1) landscapers; 2) government agencies including state and local transportation departments; 3) the residential sector; 4) commercial establishments other than landscapers; 5) garden centers and nurseries; and 6) the agricultural sector. That study involved an in-depth look at each of these markets, with surveys and interviews with end users. The current study updates key portions of the 2000 organics research, though the present market assessment is narrower in scope than the previous study. Summary information on these market segments appears in the following sections.

Landscapers

Landscapers are a large end user of compost products. In 2000, it was estimated that they purchased about 43% of the total compost sold in King County (Cascadia, 2000a). Interviews with processors for this report revealed that landscapers continue to purchase a large share of the compost and related products produced in the county. Important trends and developments include the following topics:

- **The fast-paced new home construction market experienced over the last few years has led to continued strong demand for topsoil products, including those made with compost, from landscapers.** Despite the recent economic slowdown, annual new housing starts were higher in 2002 than in the 1990s on average. A total of 11,500 new residential building permits were issued in the county in 2002 (King

County, 2003b). New regulations require that landscaping be finished before occupancy permits can be issued, further strengthening this market.

- **The impact of minimum organic content standards for soils in new developments is uncertain**. King County Code 21A.16.085, adopted in 2003, requires an organic content of 5% or more to a depth of six inches for landscaping projects. Developments including residential, commercial, industrial, institutional, and utility projects, as defined in KCC 21A.16.030, are subject to these landscaping requirements. However, we were not able to attribute an increase in compost demand to these new regulations. For example, one processor stated that they have not seen much increased demand as a result of this requirement and hypothesized that a lack of awareness, enforcement, or both may be limiting its impact. Another landscaper interviewed was aware of this regulation, though he reported that it had not applied to any of his projects conducted to date. It should be noted that the regional Soils for Salmon campaign, a program of the Washington Organics Recycling Council, is currently working with builders to increase awareness and help them effectively use compost in their operations (McDonald, 2004).
- **New Best Management Practices for stormwater management requiring an increase in organic matter may also stimulate demand for compost**. Best Management Practices T5.13 included in the Washington State Department of Ecology's 2001 *Stormwater Management Manual for Western Washington* set a guideline that the top eight inches of soil at new developments contain at least 10% organic material. King County is in the process of updating its stormwater manual and may adopt these standards.
- **Compost product quality is generally not a barrier to its use among landscapers.** In previous studies and focus groups, landscapers raised concerns about inconsistent compost quality (Cascadia, 2000a; Cascadia, 2000b; and Cascadia, 2003b). Compost users were not a primary focus of the current study, but we did conduct targeted interviews addressing compost quality with about a dozen nurseries and landscapers. Most users appeared satisfied with overall compost quality for products from Cedar Grove, Pacific Topsoils, and other sources. Some had experienced problems in the past, related to weed seeds and chemical contamination from clopyralid, but most felt that current quality is generally good. Remaining concerns include seasonal variation – particularly excessive moisture content in the winter and spring – and inconsistent particle size, such as twigs, but these factors are not sufficient to deter compost use. Some weed seeds may be present, but most of those interviewed felt that this issue was insignificant. To avoid potential quality problems, landscapers applied different compost products tailored to the needs of particular jobs.

Government Agencies

The public sector is also a major compost user, particularly state and local transportation departments, driven by the scale of their operations and procurement guidelines.

- **The Washington State Department of Transportation (WSDOT) is likely the largest single user of compost in the State.** WSDOT staff report that they purchase between one-fourth and one-third of all the compost produced in the state. Since 1998, this purchasing has been driven by RCW 43.19A.050, which has requires WSDOT to spend 80% of the total dollar amount spent on soil cover or soil amendments on compost products.
- **WSDOT expects their demand for compost to grow over the next several years.** Purchases are expected to increase as a result of the *2004 Highway Runoff Manual*. Several compost applications are included in the current version of the manual, such as compost-amended vegetated buffer strips to reduce runoff. As new compost technologies are researched and proven, they will likely be added to this manual, most likely contributing to a steady increase in WSDOT's use of compost (Salisbury, 2003). Other potential uses include compost socks and berms designed to minimize stormwater runoff.
- **King County Department of Transportation (KCDOT) use fluctuates yearly.** The King County Road Services Division maintains a contract for topsoil, with specifications that the soil consists of 15% to 30% yard waste, biosolids, and/or manure compost (Nelson, 2004). Over the last five years, KCDOT's purchases have ranged from a high of 3,500 cubic yards in 2003, to a low of about 1,400 cubic yards of compost-amended soil in 2001 (King County, 2002 and 2004).
- **Compost made from yard waste collected via King County's curbside programs is not necessarily being purchased for use in county or city projects.** Cedar Grove reports that the compost they produce is not being purchased by King County or suburban cities in any significant amounts. The company claims that the recycling loop is not being closed at the local level, as Cedar Grove believes that the local governments' potential demand is far higher than current quantities purchased (Bartlett, 2004).

Residential

Trends are generally positive for increased demand for compost products for residential yards and gardens.

- **Gardening is an increasingly popular hobby.** On a national level, a record number of households participated in gardening activities in 2001 and 2002 (Butterfield, 2003). One local processor partly attributes increased sales of compost products to this phenomenon (Bailey, 2003).

- **The increase in home buying in 2003 translates into an increase in demand in 2004.**[24] People tend to do more landscaping in the first years of owning a home than at any other time, according to one industry expert (Gage, 2004).
- **Households are the primary market for bagged compost products.** Not surprisingly, homeowners purchase most of the bagged compost product. Cedar Grove estimates that 95% of their bagged product is sold to residents, who also purchase 40% of their bulk compost. Sales of bagged compost are expected to rise substantially, with 2004 expected to match last year's 10% increase (Bartlett, 2003).
- **No data are available on residential sector market acceptance of adding food waste and compostable paper to the organic feedstock.** Initial tests at Cedar Grove show no difference in their product with the addition of food waste. Consumer preferences for compost that includes food waste could vary, however, particularly for homeowners and gardeners.
- **The market acceptance of biosolids compost is reported to have increased substantially over the last several years.** Sawdust Supply, the producer of GroCo, reports that consumer acceptance of their product has significantly increased in the past few years. Originally, the company did not strongly advertise the product, but Sawdust Supply now claims that acceptance is widespread (Winebrenner, 2004).

Other End Markets

- **Commercial sector.** Previous studies document that corporate office parks, schools, and other institutions purchase compost to meet their landscaping needs. For one processor, this market represents about 10% of bulk sales. Note that professional landscapers serve much of this market and, as a result, this commercial demand is accounted for in the landscaper end market category. This market may also use compost in stormwater management projects.
- **Garden centers, greenhouses, and nurseries.** Previous research revealed that these businesses typically purchase bulk compost for their own use, rather than for resale to consumers. As reported in 2002, however, compost-based soil blends represent less than 20% of organics purchased by this sector. Most products are peat-based, rather than compost-based. Follow-up interviews with this sector focused on compost quality issues, as prior studies had identified concerns among end users about weed seeds, pathogens, herbicides from grass clippings, and other problems (Cascadia, 2000a; Cascadia, 2000b; and Cascadia, 2003b). The current interviews suggested that perceptions of

[24] Sales of existing homes in King County increased in 2003 by an estimated 29% over 2002 figures (WSU, 2004). Construction of new homes during the same period increased by a smaller amount (4%).

overall quality had improved, and nurseries did not identify any major quality problems that were barriers to compost use.

- **Agricultural sector.** Farms, including organic farms, were not found to be a significant market for compost in 2000, and none of our research indicated that this situation had changed today. In 2000, five organic farms were interviewed about their use of compost (Cascadia, 2000a). None purchased yard waste compost due to concerns about pesticide residues. One farm anticipated buying commercial compost in the future. Of the sod farms interviewed in the same study, three of the five farms interviewed bought a combined average of 5,000 cubic yards per year of leaf and yard waste compost.
- **Specialty markets – compost tea.** According to one compost tea producer, the market for this product is in its early stages, and a large growth potential exists. Some landscapers are beginning to produce their own compost tea, since its shelf life is relatively short. Large-scale producers are also entering the marketplace, however; for example, Cedar Grove recently started selling compost tea in one-gallon containers and in bulk. The concentration of beneficial nutrients and microbes found in compost tea, coupled with its ease of application, should make it an attractive soil amendment, particularly for large users, such as state and county Departments of Transportation (Salter, 2004).

7.4 BARRIERS & OPPORTUNITIES

The recovery and processing of yard waste into compost has been a success story in King County over the last decade. But significant potential exists to divert and process more material for sale into regional markets. Enormous potential also exists to recover, process, and market food waste and compostable paper sourced from the municipal solid waste stream. This section highlights the key barriers and opportunities for organics identified in this study.

Barriers

- **The threat of contamination from persistent herbicides remains, requiring continued vigilance.** Although composters have addressed the clopyralid contamination issue for the time being by testing, buyers are still concerned and the potential exists for similar problems in the future. Clopyralid is now prohibited in landscaping applications but it is still possible to find it in manure and there are no conclusive regulations to prevent similar occurrences from other herbicides in the future. For that reason, processors need to continue product testing as well as be aware of possible future complications caused by persistent herbicides (McDonald, 2004).
- **Some users continue to express concerns about the quality and consistency of compost products.** Real and perceived problems with compost product quality may limit the market potential for its use.

Accordingly, two concerns may need additional attention: 1) lack of consistency – particularly regarding moisture content, particle size, inconsistent texture, and related issues (users interviewed generally did not cite incompletely composted or uncured material as a problem); and 2) contamination with weed seeds. These issues typically did not serve as barriers to compost use among the landscapers and nurseries interviewed. (Our interviews focused on compost buyers, however, and this study did not seek to assess whether quality was a barrier to compost application among non-users.) The need for quality varies with the end use, but improving quality can increase the value and quantity of material sold in the regional marketplace.

- **Effective standards and testing protocols for compost product quality and performance are not in place in this region.** Testing and standards are useful for organic products to protect human health and the environment as well as to verify product use and performance. The need for product safety testing is clear, and some processes are now in place for such testing, such as for clopyralid. However, such testing protocols are not required or standardized and results are not typically reported to potential buyers. Similarly, no universally accepted testing protocols, standards for product quality and performance, or a grading system for finished product are in place. Experts consulted for this study argued for such standards as a means of addressing concerns about quality and educating consumers about the compost product attributes (Gage, 2004). However, no consensus exists within the industry on whether safety or performance testing is more appropriate or how best to integrate the two (Goldstein, 2004).
- **Testing protocols and standards exist elsewhere, but no consensus exists on what method is best, and end users have not been educated.** One such program is the Seal of Testing Assurance (STA), created by the U.S. Composting Council (USCC). This program currently certifies 100 compost products using the Test Methods for the Examination of Compost and Composting Manual (TMECC), published by the USDA and USCC in 2002. The STA label can be placed on products that have paid for the certification and meet the federal and state guidelines. Compost operators can make the testing results available to customers using a Compost Technical Data Sheet. While this testing method takes into account safety and environmental concerns, the issue of product performance is not fully addressed. The STA program, for example, has similar recommended values for all end uses (Harrison, 2003). Another program is the Rodale Organic Gardening Compost Quality Seal, which uses the Solvita Compost Maturity Test. This program claims to be a more market-oriented approach to certification and is the only one available that addresses plant response (Harrison, 2003).

No consensus exists within industry or government on how to proceed with these testing protocols and related certification. Canada is currently developing national standards. However, the United States does not seem to be moving in the direction of federal standards (Goldstein, 2004). Accordingly it appears that state or local governments and/or industry must assume responsibility for these standards. Currently at the state level, the departments of transportation in several states, including Washington, Texas, and California, require a certain level of compost maturity as determined by the Solvita maturity test.

- **It is difficult for new processors to enter the composting market.** As noted, organics processing in King County is dominated by Cedar Grove, which handles virtually all curbside material. At the same time, it is extremely difficult to site a new facility in the region, because of the complexity of getting permits and finding locations that are acceptable to neighbors. As a result, competition is limited with potential adverse consequences for King County policy makers and rate payers.
- **Facilities to recover yard waste from the self-haul stream are limited.** With almost 23,000 tons of yard waste disposed, facilities are needed to recover this material for the compost market. The significant logistical and financial constraints to separating green waste at transfer stations is a barrier to market expansion.
- **Current rate structures provide an economic disincentive for food waste diversion**. Most commercial customers pay for their garbage by volume, not weight. Since food waste is heavy, food waste generators are in effect subsidized by other customers, relative to the true cost of disposal, as determined by landfill tip fees. This pricing arrangement creates a disincentive for food waste recovery and serves as an important economic barrier to development of this market.
- **Public acceptance of compost is high, but knowledge of what products to buy and how to use those products for maximum benefits is lagging**. Research shows that both professionals and home gardeners are interested in using compost and have increased their purchases over the years. Experts, however, report that many end users do not know how to use compost properly to obtain its full benefits. This lack of knowledge is seen as a barrier to expanded use of compost and thus increased sales.
- **Although current demand is strong, future end market demand may not be sufficient to handle anticipated increases in supply.** If food waste collection programs are aggressively implemented throughout the county, an additional 90,000 tons or more could be diverted over the next five to 10 years. It is unclear if the current market can absorb all this new material, and some processors are nervous about a possible market "collapse" caused by too much supply relative to demand (Bartlett, 2003).

Opportunities

- **Large quantities of compostable food waste, yard debris, and compostable paper remain in the waste stream**. The 287,000 tons of organic material disposed annually in King County landfills represents the greatest single opportunity for market development. Recovering this material for processing and beneficial use represents a major opportunity for King County.
- **Composters can increase demand by tailoring products to specific end markets.** According to industry experts, high-quality, specific markets exist, such as turf, nurseries, and gardening, but they have not been fully developed (McDonald, 2004). Different end users have different needs for compost, such as particle size, nutrient content, and consistency, for which specific product lines could be developed. Exploiting these higher-value, more specialized markets by developing blends and specialty products represents another key opportunity for market development.

  Compost tea represents another specialized product with a high potential for market growth. Compost tea products are now being marketed and sold by leading garden centers and nurseries in the region. Cedar Grove Compost recently began producing and marketing its own compost tea product. Opportunities exist to educate end users about the benefits of compost tea and stimulate increased demand for these products.
- **Increased customer knowledge is the key to expanding markets**. Experts emphasized that the key to achieving a growing, sustainable market for compost products is to have consumers fully educated about different types of compost products, their applications and benefits. With this knowledge, demand is expected to grow strongly. Without this knowledge, people could be disappointed and possibly not purchase compost again (Gage, 2004).

7.5 PUBLIC SECTOR OPTIONS

Potential options for public sector market development action include the following opportunities.

General Organics

- **Facilitate standardized product testing and certification.** King County could work with industry and state government to determine how to adequately test compost products and then establish standards for a certification program for performance. Questions to be resolved are 1) what testing is appropriate for both safety and marketing purposes; 2) what role government and industry should have in that testing; 3) what marketing standards or certification programs are needed; and 4) what entity should be responsible for establishing and maintaining those standards. King County could coordinate with other entities on this initiative including the U.S. Composting Council, the Washington State Department of Ecology, and the Washington Organic Recycling Council.
- **Increase levels of recycled organic content in government procurement.** King County already provides leadership in procurement of environmentally preferable materials. Opportunities may exist to increase procurement of compost products sourced from King County processors.
- **Collaborate with haulers to maintain material quality.** Such efforts can help ensure that processors receive feedstocks with adequate quality and minimal contamination.
- **Continue to educate the public about the benefits of compost.** Combine education efforts with existing campaigns related to Soils for Salmon, water quality, and yard waste composting. King County conducted compost marketing campaigns in 2001 and 2002. The County remains a leader in this arena, and local government has made significant progress in educating the public about compost products. However, processors and experts believe that more can be done to increase understanding of compost products and benefits. Through Northwest Natural Yard Days, King County is considering another compost marketing campaign in Fall 2004. Programs such as these can raise awareness about benefits and uses of compost.
- **Provide marketing support for higher-value organic products**, such as LinkUp's current efforts regarding Cedar Grove. Such higher-value products include compost tea and specialty garden compost blends.
- **Develop a long-term strategy to ensure adequate processing capacity in the region** and an appropriate level of competition within this industry segment.

Food Waste

- **Continue to facilitate implementation of curbside programs for food waste collection.** Such efforts should include residential and commercial customers, through expansion of pilot programs and ongoing collection.
- **Define and evaluate options for a least-cost collection, handling, transfer, and transportation system** for food waste collected from commercial sources.
- **Assess commercial solid waste rate structures and identify opportunities to influence rates or introduce other financial incentives** to encourage the diversion of food waste from disposal, including tip fee surcharges, if applicable.

Yard Waste

- **Consider banning the disposal of yard waste at transfer stations**, **and enhance recycling facilities for yard waste.** Provide recycling incentives, such as reduced tip fees, appropriate infrastructure, and compost products to increase yard waste recycling. King County could also promote use of existing private-sector collection drop boxes and facilities for yard waste recycling.
- **Continue initiatives to purchase compost for public sector** transportation and landscaping projects.
- **Evaluate use of compost for erosion control** in Pacific Northwest climates.

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Chapter 8
Paper

8.1 INTRODUCTION

Recycling has played a key role in paper manufacturing since its inception, when the first papers made centuries ago included recycled materials such as cotton rags. Modern paper recycling dates to the early 20th century, with a patent for making paper from deinked wastepaper issued in 1916 and wartime paper drives to combat shortages during both World War I and II. Paper recycling has increased significantly in the last decade, and demand for recycled paper remains strong.

Recycled paper and cardboard are valuable commodities, and market demand largely drives their recycling. Manufacturer demand for the materials has historically propelled their recycling, in contrast to other materials where the desire to reduce material in the waste stream is a stronger driver of recycling. In the marketplace, recycled fiber competes with virgin pulp from logging operations, and recycled paper prices typically track increases and decreases in the prices for virgin pulp.

Strong export markets are currently driving increases in prices for recovered paper, and today's marketplace shows the largest differential to date between domestic and offshore prices. Though this competition means that King County's paper supplies currently command high prices, this situation could have an adverse effect on the marketability of King County's paper supplies in the long run. Competition from Asian mills results in higher prices and lower supplies for Northwest mills, which may affect their continued economic viability. If domestic mills downsize or use less recovered fiber, King County and the region could become more dependent on the overseas marketplace for paper recycling – and thus vulnerable to any downturn or other changes in those markets.

8.2 MARKET CONDITIONS

Supply

On the supply side, paper recycling rates are relatively high, ranging from 59% for mixed waste paper to 69% for cardboard. These high recycling rates make it difficult to increase future supplies significantly, as much of the more readily recoverable material has already been captured. However, the commercial waste stream and mixed waste paper both offer opportunities for increasing future supplies of recyclable paper. Strong demand for recycled paper from overseas mills is raising prices for recycled fiber and increasing competition for domestic mills. Additionally, the trend towards single-stream collection of commingled recyclables can reduce the quality of recycled paper supplies, so

processors and mills may need to adjust their practices to remain competitive. The following list summarizes key conditions affecting supplies of recycled paper materials.

- **Recycling rates for recoverable paper are high.** King County currently enjoys high recycling rates across the principal grades of recoverable paper. Current recycling rate estimates are as follows: old corrugated cardboard (OCC) at 69%; old newspapers (ONP) at 61%; and mixed waste paper (MWP), including high-grade and office papers, at 59%.[25]
- **High recycling rates limit future supplies.** Of the 392,000 tons of recoverable paper currently generated in King County outside Seattle, only about 146,000 tons of these recyclable papers remain in the disposed waste stream. Since the more readily recoverable material – the figurative "low-hanging fruit" – largely has been captured, particularly from the commercial waste stream, future supplies will be more difficult to secure.
- **The commercial waste stream represents the largest remaining source of recycled fiber.** Although its paper recycling rate is higher (70%), King County's commercial sector still disposes of more recyclable paper than either the residential or self-haul stream – more than 70,000 tons annually. Many businesses do not have recycling collection services or choose not to recycle. With their lower recycling rates, the residential (55% paper recycling rate) and self-haul substreams (24%) also represent significant opportunities for increased paper recovery.
- **Mixed paper represents the greatest opportunity for increasing the current supply of recyclable paper.** Mixed waste paper constitutes about one-half of the recoverable fiber in the residential and commercial disposed waste streams, and MWP currently has the lowest recycling rate of the major paper categories.
- **Due to offshore demand for recycled paper, some domestic mills are beginning to experience a supply shortage.** Recent price increases support the claims by industry experts that competition for recycled paper is increasing in the Northwest and that this shortage and the associated higher prices may adversely affect the profitability of regional mills. In response, some mills may shift to using larger proportions of virgin feedstock, as prices for recycled fiber increase and the supply remaining in the region decreases.
- **Paper recovery, especially from the commercial sector, is sensitive to prices.** High prices, which are likely in the near term, may increase supplies of materials recovered, particularly for OCC. During a previous period of peak prices in 1994-1995, supplies of cardboard recovered

[25] These estimates include residential, commercial, and self-haul streams in King County excluding Seattle.

increased. Collection became more cost-effective for smaller businesses, and the "mosquito fleet" of non-franchised haulers prospered and grew in size.

- **Embedded recycling collection services for commercial customers will increase paper recovery over the next couple of years.** Several King County suburban communities have or will soon offer recycling services to businesses at no additional charge. The cost of recycling will be "embedded" in the garbage charges. This embedding is expected to result in additional diversion of 6,000 to 16,000 tons of recyclable paper, as more businesses participate in recycling.
- **Bans or other forms of mandatory recycling initiatives could increase supplies.** A recent study completed for King County estimated that from 25% to 75% of the disposed recyclable paper in the commercial waste stream could be diverted through mandatory recycling programs, depending on the level of enforcement.
- **Commingled collection of recyclables is here to stay.** The trend towards commingled collection of recyclables is continuing, and haulers are seeking to include glass in the mix (single-stream recycling). As a result, the quality of future recycled paper supplies from residential curbside collection and commercial commingled programs may decline, particularly with the inclusion of glass. Mills may have to adjust to handle increased contamination levels, or the recovered paper may need additional processing to remove glass contamination.

Current Supply

The following table summarizes the quantities of recyclable paper generated by King County's residential, commercial, and self-haul waste streams. As the table indicates, the total supply of recyclable paper in King County (excluding Seattle) is roughly 392,000 tons.

Table 8-1. King County Recyclable Paper Generation, by Sector
(excludes Seattle)

	Disposed	Recycled	Total Generated	Recycling Rate
Residential	61,795	76,987	138,782	55%
Commercial	70,561	164,748	235,309	70%
Self-Haul	13,623	4,360	17,983	24%
Total	145,979	246,095	392,074	63%

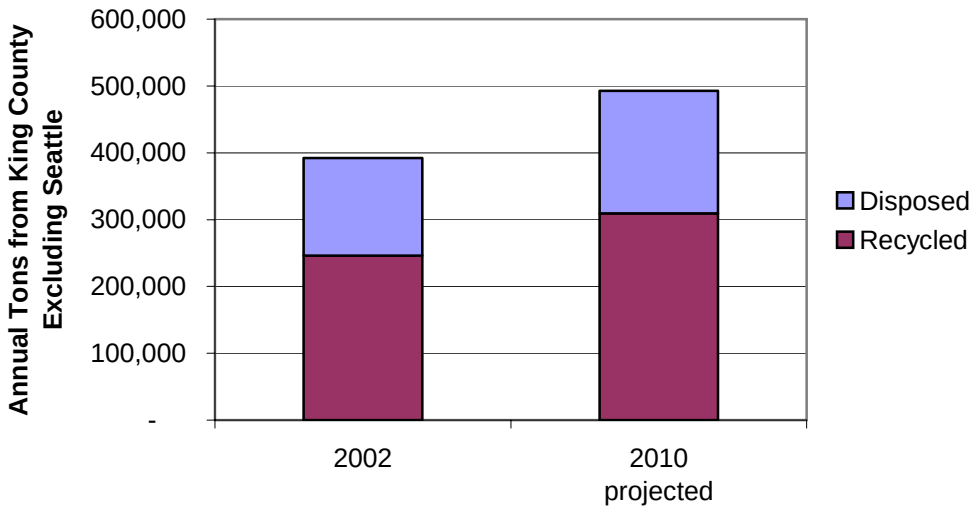
Projected Supply

Paper generation in King County is expected to grow over the coming years as population and economic activity increase. Based on econometric modeling conducted by King County Solid Waste Division, we have projected a status quo future where paper generation increases but the recycling rate remains constant.

Projections by Solid Waste Division staff predict that approximately 26% more waste will be generated in 2010 than was generated in 2002 (Rist, 2003).

The following figure graphically displays this expected increase. Note that this projection does not take into account potential policy changes such as disposal bans or other policies intended to increase paper recycling.

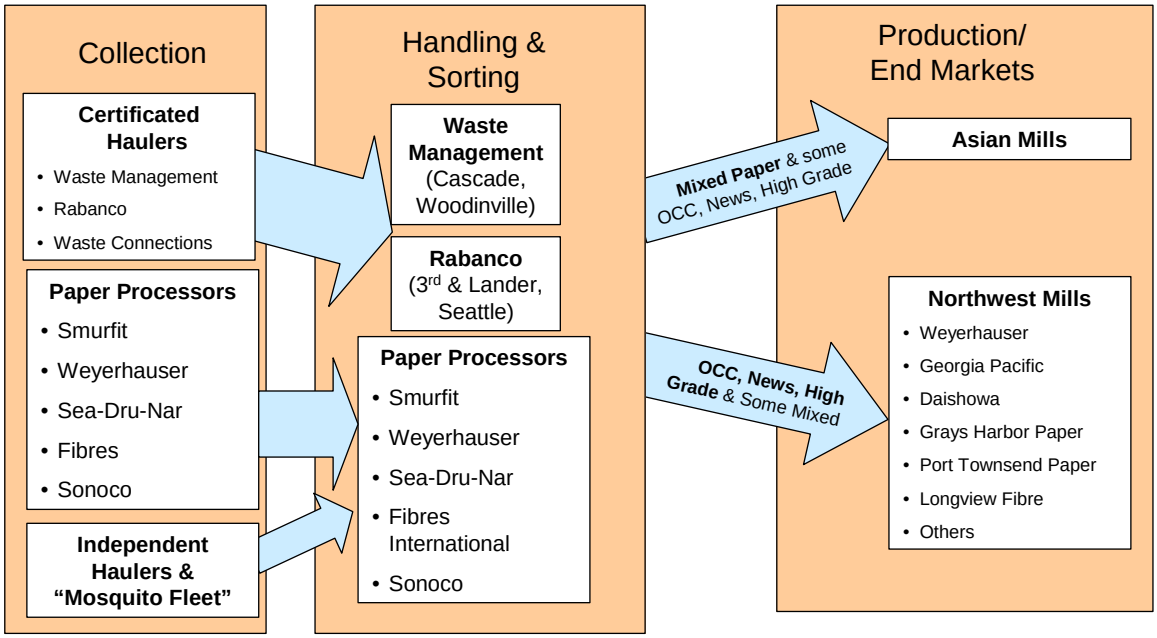
Figure 8-1. Total King County Recyclable Paper Generation: Current and Projected Status Quo
(excludes Seattle)



Processing & Infrastructure

King County currently has an extensive and well-developed collection system for paper recycling, with most materials handled by a certificated hauler (i.e., Waste Management, Rabanco, and Waste Connections) or a "big four" processor: Fibres International, Sea-Dru-Nar Recycling, Smurfit Recycling, and Weyerhaeuser. Some processors currently sort mixed waste paper into its component higher grades. The existing infrastructure for collection and processing are sufficient to manage current supplies, and they could handle additional recyclable paper if supplies increased. Figure 8-2 illustrates the existing supply chain for recycled paper generated in King County, including collection, handling and sorting, as well as production and end markets. Following the figure, a series of bullets describe King County's processing and infrastructure for recycled paper.

Figure 8-2. Current Supply Chain for Recycled Paper Generated in King County



The following list provides more information about King County's processing and infrastructure for recycled paper.

- **King County benefits from a highly developed collection system.** The principal grades of recyclable papers are currently collected in residential curbside programs, through drop-off collection, and from businesses by the haulers and numerous independent recyclers.
- **Most of the recyclable paper is collected and/or processed by the certificated haulers or one of four major processors**: Fibres International, Sea-Dru-Nar Recycling, Smurfit Recycling, and Weyerhaeuser. The haulers and these "big four" processors handle over 80% of the paper recycled from King County, excluding Seattle; Sonoco is an additional processors in the region, though it handles a smaller volume of paper from King County. Some of these processors have expressed concern over the increasing influence of Asian mills on the domestic marketplace, and they report focusing on maintaining relationships with a diverse, balanced mix of buyers, even if it means selling some materials at lower prices in the short term.
- **Some processors are sorting mixed waste paper**. The purpose of this sorting is to remove high grades such as white ledger or to "clean up" their mix so that it meets specifications for "office-pack" paper. A $30/ton differential between the mixed waste paper price and the price of the higher grade, after sorting, is reported to make this sorting economically viable at the current time.

- **Currently, processing capacity that serves King County is not fully utilized.** All of the processors and haulers that were interviewed indicated that they could handle more material. Many of the plants indicated that they were running only one or two shifts. Collectors and processors reported that local infrastructure for paper collection and processing is adequate, but efforts to increase the quantities recycled would benefit the system.

End Markets & Prices

Paper markets are strong, and demand for recovered paper continues to rise, as Asian mills increase their capacity. Most cardboard and newspaper from King County currently flows to Northwest mills, while China and Southeast Asia buy almost all of the mixed waste paper stream. Paper markets are becoming more globalized, reducing the influence of local governments on the marketplace. King County currently benefits from dual domestic and offshore markets for its recovered paper, but increased foreign competition could diminish the profitability of Northwest mills and eventually weaken markets for local paper supplies. The list below highlights key factors regarding end markets for King County's recovered paper.

- **Markets are strong and demand is high, largely due to increasing offshore mill capacity.** Even though domestic capacity will likely decline in the short term, offshore expansion of mill capacity in China and the rest of Southeast Asia is expected to produce strong market conditions for recycled fiber. Among other factors, demand is driven by customers wanting recycled content, the need for high-quality packaging to ship increasing quantities of industrial and consumer goods from Asia to Europe and North America, and the continuing and growing requirements for communication papers in the developing world. Key stakeholders describe paper markets as solid, resilient, and robust.
- **Offshore markets are growing, particularly in China, and are likely to continue to drive prices upward for secondary fibers.** Overseas markets enjoy lower production costs, and China alone is reported to be adding more than 1 million tons of new mill capacity per year over the next several years. Some analysts, however, have predicted a likely slump in the Chinese economy, which could result in lower prices for recovered paper and other commodities. Increased production, use, and internal recovery of paper in Southeast Asia could also reduce offshore demand for recycled paper from North America.
- **The status of domestic mills remains questionable**, due to international competition and other economic forces. If prices for finished paper grades from domestic mills fail to increase, which is unlikely due to competition from less expensive offshore mills, the profit margins for domestic mills will grow thin. Without domestic mills, the markets for King County fiber would be less reliable, as the dual

domestic and offshore markets – which compete for recycled paper and are both available to Northwest processors – would be lost.

- **Prices are relatively high and are expected to remain so over the next couple of years.** The increased demand in Asia could cause a long-term increase in prices for all grades of recovered paper, as long as Asian markets remain strong.
- **Local policies will have little impact on demand or prices for recovered paper.** More than ever before, recycled paper markets are global in nature. Demand and prices are to a large extent driven by international economic conditions, such as the growing Chinese economy.
- **Requirements for recycled content in finished paper products support recycling.** Government mandates for minimum recycled content standards, including post-consumer waste, have played an important role in increasing the use of recycled materials in paper. In response to government efforts and consumer demand, more recently some major retailers have also adopted such standards, including Staples and Kinko's requiring 30% post-consumer recycled content in their paper supplies.

Cardboard (OCC) & Newspaper (ONP)

- **Most cardboard and newspaper supplies from King County still flow to domestic mills in the Northwest.** Mills in Washington, Oregon, and Canada currently purchase most recycled cardboard and newspaper collected in King County.
- **More OCC and ONP are beginning to move overseas**, as rising Asian demand fuels price increases. In the future, some industry experts predict that most cardboard will flow offshore.

High-grade Paper

- **Most high-grade paper recovered from King County stays in the region**, though export demand for these materials is increasing.

Mixed Waste Paper (MWP)

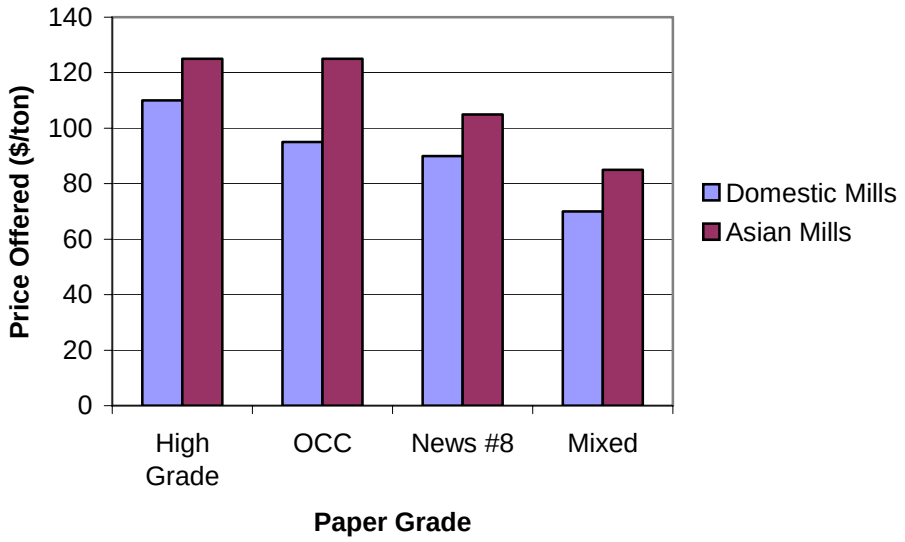
- **Virtually all mixed paper is going offshore to China and other Southeast Asian countries.** Some mixed paper is sorted into higher grades, and a small amount is used in domestic cardboard production. This condition is expected to remain the case, as offshore demand for mixed waste paper continues to grow.
- **Alternative uses for recycled paper are expanding.** Recycling paper back into new paper or cardboard is the most desirable form of recycling, but it is also highly capital-intensive. Other, often smaller-scale, operations for paper recycling are growing as part of the e-commerce, construction, and environmental products industries. Applications for

recycled paper in construction include **cellulose insulation** made from recycled newspaper, **homasote fiberboard** made from newspaper used for insulation, soundproofing, and bulletin boards; **composite countertops** made from recycled paper and plastic resin (Richlite and PaperStone are two manufacturers); **paint filler**; **roofing and decking** made from newspapers compressed together with adhesives; and **facing paper** for gypsum wallboard. **Molded-pulp packaging** – such as egg cartons, fruit trays, and "e-cubes," a paper packaging alternative to styrofoam "peanuts" – is a growing use. Additionally, recovered paper is also used in **paper mulch compost** made from recycled newspaper; **hydroseeding medium** for grass and other plantings; flushable **kitty litter** made from recycled newspapers; **animal and worm bedding** made from shredded paper; and **fuel blocks** made from unrecyclable paper and other waste fibers. Some of these applications require smaller capital investments in manufacturing infrastructure, so they have the potential to provide viable local alternatives to paper mills.

Prices

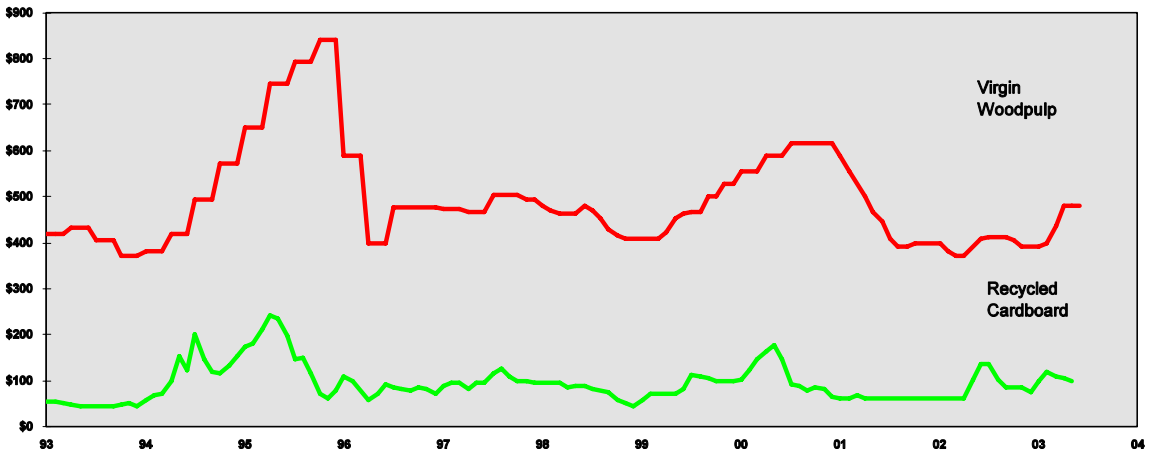
Prices for recovered paper currently range from about $70 to $125 per ton, depending on the type of material and the market, as shown in Figure 8-3. Cardboard commands the highest prices ($95-125/ton), with newspaper close behind ($90-105/ton), particularly in domestic markets. Prices are lower for mixed waste paper, ranging from $70 to $85 per ton. Asian mills consistently pay higher prices for King County's recovered paper: an additional $15 per ton for ONP and MWP and up to $30 more per ton for OCC.

Figure 8-3. Prices Offered for Recycled Paper by Domestic and Asian Mills[26]



Prices for recycled paper typically track the prices of virgin materials, while consistently remaining cheaper by several hundred dollars per ton. Figure 8-4 compares prices over the last decade for virgin wood pulp (unbleached softwood kraft pulp) and recycled cardboard.

Figure 8-4. Virgin and Recycled Prices for Unbleached Softwood Kraft Pulp versus Recycled Cardboard, 1993-2003[27]



[26] Except for high-grade paper, the prices in this chart are based on averages reported by a local paper recycler. Prices for high-grade paper were estimated based on other limited information, and will be updated with actual prices when that information becomes available.

[27] Sound Resource Management Group, www.zerowaste.com.

8.3 BARRIERS & OPPORTUNITIES

Paper markets are robust, and prices are rising, but the global marketplace poses some challenges for recycling of paper from King County. The rise of single-stream recycling may reduce the quality of recovered paper, making it more difficult for manufacturers to reuse the material in creating new products. The following barriers affect markets for recycled paper in King County.

- **The recycled paper marketplace is global in nature, so local factors exert little influence.** King County currently benefits from the competition between domestic mills and overseas facilities in China and Southeast Asia, as multiple marketing options allow the region to command higher prices for its recovered paper. However, the growing Asian markets could make domestic mills less profitable, diminishing the benefits of this dual marketplace.
- **Manufacturing from recycled paper requires major capital investments, limiting new entrants into the marketplace.** New paper mills require multimillion-dollar capital investments. Accordingly, a reliable supply of quality feedstock is necessary to justify the investment. High start-up costs keep the number of manufacturers in the paper marketplace relatively low and create a substantial barrier for new manufacturers. New local mills are unlikely to open in this economic climate.
- **Commingled recycling can reduce the quality of recovered paper**, making it more difficult for mills to use recycled materials in their production. The increased use of single-stream collection of recyclables, particularly with the inclusion of glass, has adverse impacts on the quality of recovered paper. Local mills report that this contamination further hinders their ability to compete with Asian mills, making it harder to use local recycled paper supplies in local manufacturing.

Given the barriers associated with the global marketplace, coupled with the strong demand for recovered paper, most of the opportunities in the paper market focus on increasing the supply side. These opportunities are also discussed further in the *Public Sector Options* section below.

- **Increase commercial paper recycling.** The public sector can take several actions, covered in the section below, to boost paper recycling among businesses. Efforts could focus on the business services sector – the largest disposer of recyclable paper – which includes the high-tech and software industry, advertising, printing and copying services, and direct mail centers.
- **Increase paper recycling in the self-haul substream.** The paper recycling rate is lowest in the self-haul substream (24%). Promotion, education, and increased convenience could help increase paper recycling among those who self-haul their waste to transfer stations.

- **Increase recycling of mixed waste paper, particularly among residents.** The recycling rate for mixed waste paper is lower than the rate for cardboard or newspaper. As noted in the section below, education and promotion could help raise this rate.

8.4 PUBLIC SECTOR OPTIONS

Though King County has well-developed markets for recycled paper, several opportunities exist for increasing supplies and enhancing overall paper recovery, as discussed in the list below.

- **Promote the adoption of embedded recycling rates to increase commercial paper recycling.** King County recently completed a study of *Options to Increase Commercial Paper Recycling in King County*, which includes a number of recommendations designed to increase paper recycling in the commercial sector (Cascadia Consulting Group and Sound Resource Management Group, 2004). Embedded recycling rate structures involve offering universal recycling service to all businesses, with the cost included in their garbage rates. Since recycling is automatically available, instead of businesses paying extra for the additional service, more companies are likely to participate in recycling. King County should encourage suburban cities that contract for commercial waste collection to adopt embedded rates when the contracts come up for renewal.
- **Adopt disposal bans, strengthen enforcement, and consider mandatory recycling to increase commercial paper recycling.** As addressed in King County's recent study of *Options to Increase Commercial Paper Recycling in King County*, bans on the disposal of recyclable paper, coupled with mandatory recycling and enforcement, would also boost supplies of paper recovered from the waste stream (Cascadia Consulting Group and Sound Resource Management Group, 2004). Like the ban that Seattle recently adopted, such a ban should cover the disposal of cardboard, newspaper, and mixed waste paper from the commercial sector.
- **Improve facilities, education, and promotion to increase paper recovery from self-haul customers.** The self-haul substream has the lowest paper recycling rate (24%). Recycling facilities at most King County transfer stations accept cardboard, newspaper, and mixed waste paper, but the Algona site lacks recycling. Education and promotion may help increase recycling among these customers. The cost structure and facilities should be designed to provide incentives for recycling, as some customers may find it easier to dispose of recyclables than to recycle if they are only paying the minimum tip fee ($15.25 for the first 320 pounds).

- **Promote residential recycling of mixed waste paper.** Recycling rates for mixed waste paper are lower than for the other paper materials that have a longer history of recycling, such as newspaper and cardboard. Some residents remain unclear on the extent to which paper materials – such as junk mail, catalogs, magazines, and window envelopes – can be recycled. A new round of education and promotion focusing on mixed waste paper would help boost recovery of these recyclable materials.
- **Consider options for making single-stream recycling collection systems more compatible with recycled paper manufacturing.** Local users of recovered paper have complained about the impact of glass contamination on their production process. With haulers moving towards single-stream collection of all recyclables, this problem may increase. In 2004, Seattle Public Utilities is conducting a study of single-stream collection, its potential impacts on the recycled paper industry, and ways to address any processing problems. King County and other local governments should consider the findings of this study, when complete, to assess additional research needs and identify appropriate policy actions, if any.

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Chapter 9
Plastics

9.1 INTRODUCTION

The state of King County plastics recycling has seen some major changes in the last few years in all steps of the supply chain. Plastics are an increasingly common material in consumer products. In particular, plastics are replacing other materials, especially glass, in food and beverage packaging, and are being used in an increasing array of single-serve products. Opportunities for plastics recycling in King County have grown steadily in the last few years, as an increasing number of communities have turned to plastics recycling as a means to boost recycling rates and satisfy public demand for increased recycling services. Yet as more plastics are being produced and collected, local sorting and processing of rigid plastics has declined, as material revenues have been insufficient to support expensive sorting and processing operations. As a result, all rigid plastics are currently sent out of the country (although many only travel as far as Vancouver, British Columbia). This section of the report will provide more detail on the supply, processing, and end markets for King County plastics, and highlight some opportunities for increasing the state of plastics markets.

The types of plastics that will be covered in this chapter include:

- **PET bottles** (resin code #1) – bottles made from polyethylene terephthalate (PET), consisting of soft drink, juice, liquor and other types of bottles;
- **HDPE bottles** (#2) – bottles made of high density polyethylene (HDPE), typically used to contain milk, detergent and other liquids;
- **Other rigid containers** – all other rigid containers (including containers with resin codes #3 through #7 and non-bottle PET and HDPE), such as tubs, yogurt containers and other bottles; and
- **Film** – all film, bags and thin plastic packaging, including wrappings, vacuum-formed packaging, bubble packs and other films, as well as plastic strapping and other thin flexible plastic packaging.

9.2 MARKET CONDITIONS

Trends & Key Variables Affecting Supply

Although PET bottles (such as soda bottles) and HDPE bottles (such as milk jugs and detergent bottles) have long been collected curbside for recycling, the last few years have seen a dramatic growth in the variety of plastics accepted in King County's curbside recycling programs. In 1998, no curbside programs in King County accepted any plastics other than PET (#1 resin code) and HDPE (#2)

bottles. Now in 2004, many communities as well as unincorporated King County also include most other rigid plastic containers. This trend has largely been driven by communities' desire to increase recycling rates by collecting more plastics – but as we will discuss below, markets for these other items are often poor or non-existent. The following points provide more detail on the supply of recyclable plastics in King County.

- **PET has continued to gain market share in the bottling industry.** The previous market update (Cascadia Consulting, 1998) emphasized that PET was rapidly becoming the container of choice for most juice and soft drink manufacturers. This trend has continued, although growth has slowed somewhat. The National Association for PET Container Resources (NAPCOR) reports that, by weight, twice as many PET bottles were on the shelves in 2002 as there were in 1995 (NAPCOR, 2003). PET growth was the fasted in 1997-1998, when it was estimated at 18%; growth for 2001-2002 was estimated at 6% (NAPCOR, 2003). For the most part, growth in the PET market has come in single-serve juice, soda, and water bottles. Consumer recycling behaviors have not kept pace with the increased supply of these items in the marketplace, however, a trend partially explained by the tendency for consumers to consume single-serve beverages away from the home where recycling services are less convenient.
- **Recycling rates for plastics are relatively low and may be falling.** In King County, recycling rates for PET (#1) and HDPE (#2) are estimated at 25% and 31%, respectively. Nationally, recycling rates for plastic containers have been falling since the mid-1990s. The National Association for PET Container Resources (NAPCOR) estimates that the national PET recycling rate has fallen from 40% in 1995 to 20% in 2002 (NAPCOR, 2003). The primary reason for this decline is that although use of plastic bottles and containers has increased dramatically, the quantities recycled have remained virtually constant.
- **Local collection programs are expanding to include all plastic bottles and often all plastic tubs.** Several cities in King County have expanded beyond the traditional PET and HDPE plastics to accept all bottles (with resin codes #1-7) or all bottles and other rigid containers in their residential curbside programs.
- **Collection of residential plastic film in King County is currently limited to certain grocery stores.** Unlike Seattle, cities in King County have not expanded their curbside recycling programs to include plastic bags. However, several grocery store chains, such as Albertson's, Safeway, and QFC, among others, offer residents the opportunity to return their plastic bags for recycling. This material is sold to Trex, a plastic lumber manufacturer with a facility in Nevada.
- **Recycling of commercial plastic film has been on the rise.** Large end users of plastic film, particularly Trex, have made plastic film

collection cost-effective for business and industry. Until a recent production difficulty, Boise Building Solutions purchased significant quantities of King County's plastic film from Marathon Recovery/Re-Sourcing Associates for test runs in its wood/plastic composite siding facility in southwestern Washington.

Current Supply

The following table summarizes the quantities of plastic bottles, jugs, jars, and tubs (PET, HDPE, and other resins) generated by King County's residential, commercial, and self-haul waste streams. As the table indicates, the total supply of these plastics in King County (excluding Seattle) is roughly 27,000 tons. Note that plastic film is excluded from this table because data from the primary collectors and processors were unavailable.

Table 9-1. King County Recyclable Plastics Generation, by Sector
(excludes Seattle)

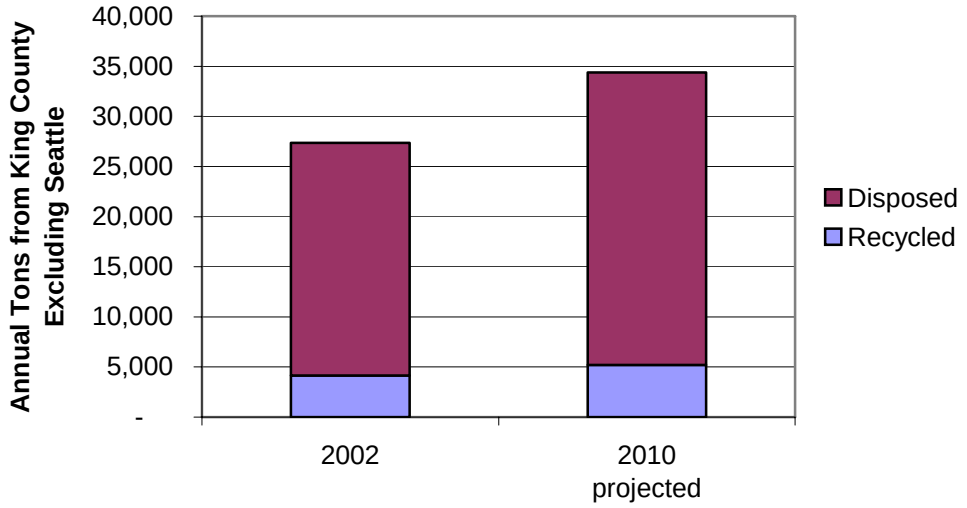
	Disposed	Recycled	Total Generated	Recycling Rate
Residential	11,473	2,619	14,092	19%
Commercial	9,365	1,372	10,737	13%
Self-Haul	2,368	160	2,528	6%
Total	23,206	4,151	27,357	15%

Projected Supply

Projections by King County Solid Waste Division staff predict, based on econometric modeling, that approximately 26% more waste will be generated in 2010 than was generated in 2002 (Rist, 2003). Accordingly, plastic generation in King County is expected to grow over the coming years as population and economic activity increase. Based on King County's waste projections, we have projected a status quo future where plastic generation increases but the recycling rate remains constant.

The following figure graphically displays this expected status quo increase. Note that as in Table 9-1, the following figure does not include plastic film. Additionally, this projection does not take into account potential policy changes or economic incentives that could affect plastics recycling.

Figure 9-1. King County Recyclable Plastic Generation: Current and Projected Status Quo
(excludes Seattle)

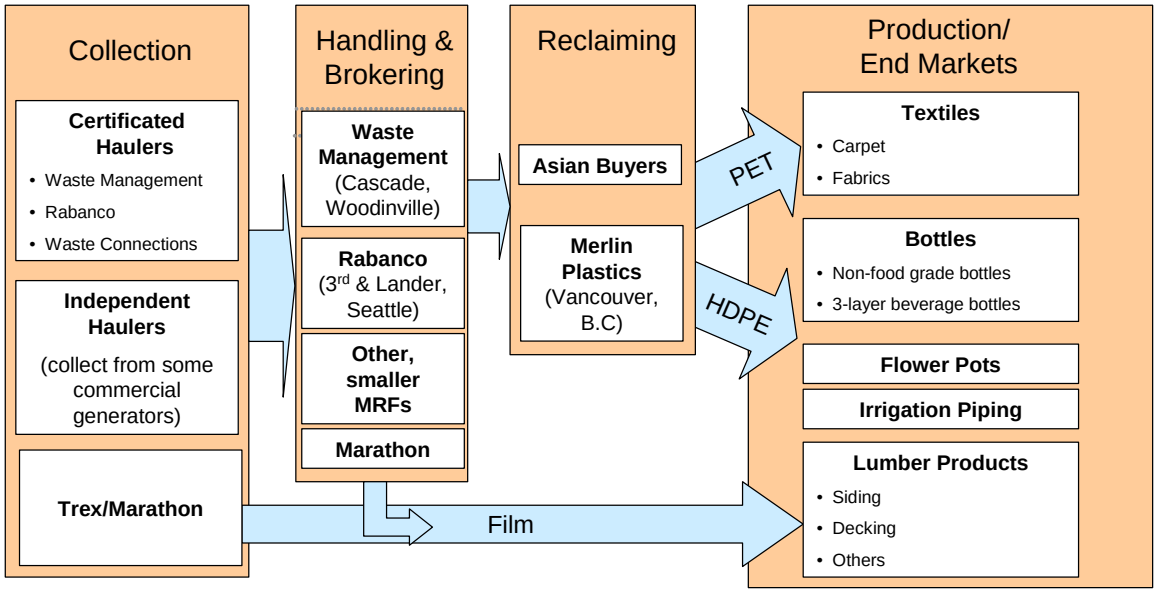


Processing & Infrastructure

As a wider array of rigid plastics have been collected for recycling, local sorters and processors have had to adjust how they sort and market their plastics. Increasingly, recyclers around the Northwest are sorting less and exporting more, as the increased value gained by sorting does not support the labor required, especially when considering the low value of resins other than PET and HDPE.

Figure 9-2 displays the supply chain for recyclable plastics collected in King County.

Figure 9-2. Current Supply Chain for Recycled Plastics Generated in King County



The following points further describe the collection and processing of rigid plastics and plastic film.

- **The large haulers dominate collection of plastic bottles and containers.**
- **The infrastructure for collecting plastic film, on the other hand, is controlled largely by the end markets.** The growth in the plastic and composite lumber industry has led to vigorous demand for plastic film. The largest players – Trex and Boise – have set up their own collection infrastructure or contracted with companies to procure stable supplies of plastic film. Trex operates collection programs throughout the West Coast to supply material to its Nevada manufacturing facility. Marathon Recovery/Re-Sourcing Associates, based in King County, has been sending film to Boise Cascade's new facility near Elma in southwestern Washington, until a recent delay in the Boise plant's operations.
- **Rigid plastics are handled largely at one of two major material recovery facilities.** Rabanco/Allied's Third & Lander facility and Waste Management's new Cascade Recycling Facility in Woodinville are the major processors of recycled plastics. In addition, Waste Management-Recycle America operates two smaller MRFs in Seattle and Auburn. Smaller recyclers such as Sea-Dru-Nar also handle plastics.
- **Less sorting of plastics by resin type is occurring in King County.** Most notably, Rabanco/Allied's Third & Lander facility is no longer sending rigid plastics to Fibres for sorting, opting instead to market mixed bales directly to Asian buyers, mostly in Hong Kong. Waste Management's Woodinville facility is still sorting out PET and HDPE.

- **Allied/Rabanco's Third and Lander facility is focusing fewer resources on plastic film.** The Rabanco/Allied facility has recently made a decision to focus fewer resources on plastic film. The price obtained for the film from Marathon Recovery reportedly did not cover the costs of sorting it to Marathon's specifications. Accordingly, the facility has cut back the staff time assigned to pulling film off the pick line and is now accepting a much lower price from a Canadian market. However, this development currently has little impact on film collected in King County outside Seattle, as King County film is collected at grocery stores or from commercial generators rather than in curbside recycling programs.

As noted above, the infrastructure for plastic film is controlled largely by the manufacturers that use the recycled materials. Rigid plastics, on the other hand, must be processed before they can be remanufactured as new products, a process often referred to as *reclaiming*. This process may involve some further sorting, but generally includes washing followed by various forms of physical transformation (including grinding, flaking, and pelletizing). However, plastic reclaimers have consistently been going out of business in the last few years, and there is now only one major reclaimer in the region – Merlin Plastics in Vancouver, B.C. This leaves collectors of recyclable plastics with essentially only two options – sell to Merlin or sell to Asia.

The following points provide further detail on the state of plastics reclaiming in the region.

- **No major reclaimers of plastic are located in King County.** The nearest major reclaimer is Merlin Plastics in Vancouver, British Columbia.
- **Merlin Plastics in Vancouver, B.C., has recently entered the PET and film markets.** Previously only a destination for HDPE, Merlin has added a new facility to flake PET (Anderson, 2003). They have also begun brokering film, and they expect to begin processing it in the near future.
- **Trex – previously a processor and remanufacturer of only plastic film – may be entering the container market.** A contact from Merlin Plastics reports that Trex has begun procuring supplies of rigid containers in British Columbia, potentially providing some domestic competition for Merlin. As of yet, there have been no reports of Trex entering the King County container marketplace.
- **Technology for sorting, washing, and grinding plastic is evolving.** The economics of plastics recovery are shrinking the role of hand-sorting in plastics recycling, as the increased revenues gained by sorting are not sufficient to cover the increased labor costs. As hand-sorting becomes less common, an opportunity is emerging for technology to sort plastic resins from each other. One contact reported an emerging European technology that can sort the various forms of HDPE based on their

different melting points. Decreased hand sorting also brings the need for improved wash line and grinder technology that can remove contaminants.

End Markets & Prices

Recent years have seen many changes regarding the end markets and marketing practices for King County-generated plastics. Most notable is the rapid expansion of the plastic film market, and another development is Rabanco's decision to market a #1-7 bale of plastics to Asia rather than sort PET from HDPE. If other recyclers follow suit, the distinction between PET and HDPE markets may begin to fade. Below we present information about the grades separately, but it is important to note that processors throughout the Northwest are in the midst of an apparent shift away from marketing these individual grades.

PET Bottles (#1)

Markets for PET bottles (resin code #1) are currently quite strong, driven by large domestic and Asian demand. Following are more specific findings about markets for PET collected from King County.

- **Plastics processors in King County most often market their PET in Asia**, where they report they can often get a $0.01 to $0.02 per pound premium over the prices offered by domestic reclaimers such as Merlin in Vancouver, B.C.
- **Merlin Plastics in Vancouver, B.C., is also a destination for King County plastics.** Merlin's PET operation has grown significantly, and the company now reclaims as much PET as it does HDPE (Anderson, 2003). The company is reportedly interested in expanding to gain market share of the U.S. plastic supply, but it has some quality concerns about material from commingled programs. In addition, one buyer for Merlin reports that U.S. companies are less willing to enter into contracts than their Canadian counterparts (Andrews, 2003). Still, a number of our contacts throughout the Northwest have reported long-term relationships with Merlin as well as the tendency to send Merlin their full suite of plastics, not simply HDPE as was common in the past.
- **Recycled PET is used primarily in carpets and fabrics**, with a small percentage going to other applications such as nylon strapping.
- **Plastic reclaimers hope that the introduction of the three-layer beverage bottle will dramatically increase the quantities of PET recycled into bottles.** The Food and Drug Administration requires that food grade bottles cannot include recycled plastic unless it is sandwiched between two layers of virgin plastic. Although this has hindered closed-loop PET bottle recycling, several forces are reportedly aligning to make three-layer bottles a reality: 1) the environmental lobby, which has been pressuring Coca-Cola and others to meet minimum content standards; 2)

cost savings experienced by using recycled resins instead of virgin; and 3) increased shelf life, from three to nine months, of three-layer bottles (Anderson, 2003).

HDPE Bottles (#2)

Like PET markets, demand for HDPE resins is also quite strong, with good Asian and domestic demand. As with PET, Merlin Plastics in Vancouver, B.C. and Asian markets are generally the only viable options. The following points provide further detail.

- **HDPE is marketed domestically and overseas.** About half of the HDPE collected is marketed to Asia, and about half is marketed domestically. Ernie Chambers, a commodity sales specialist with Recycle America, reports that Asian demand has increased since the late 1990s (Chambers, 2003).
- **Recycled HDPE is used primarily in irrigation piping, flower pots, and non-food bottles.** Colored HDPE is used in corrugated irrigation piping, which averages 65% recycled content, and flowerpots, which are often 100% recycled plastic. Colored HDPE is also used in garbage bags that have a low recycled content. Natural-colored HDPE is used to make non-food grade bottles such as detergent and motor oil bottles (Anderson, 2003; Chambers, 2003)

Other Rigid Plastic Containers

Unlike PET and HDPE bottles, markets for other rigid plastic containers are poor.

- **Few markets exist for other rigid containers (#3-7) and non-bottle PET and HDPE (#1 and #2).** Recyclers report that they are often pleased simply to get rid of these items with little or no compensation. In the last several years, markets have been relatively stable at about half a cent per pound ($0.005/lb). In the late 1990s, markets were more variable, and sometimes no markets existed. Currently all #3-7 plastics are exported.
- **Recyclers often are not aware of the end uses of exported materials.** Some recyclers surveyed for this study were not aware of the end uses for the exported mixed rigid containers, and one expressed concern that most of the material may be landfilled. One large exporter reported that Chinese processors are using non-bottle and #3-7 rigid containers to make non-food grade containers and bags.
- **In the past, #3-7 and non-bottle rigids occasionally went to a diesel converter in Kelso, Washington.** This market reportedly no longer exists, but technology appears to be advancing in this arena, with several companies working on methods to generate fuels from recovered plastics. One such company, Western Research Institute, has received support from the Department of Energy to advance its technology (Western Research Institute, 2003).

- **Markets for non-bottle and #3-7 plastics would likely improve if they were present in greater volumes.** Markets for these plastics have not developed in part because the supply is relatively low. As more King County cities begin to include the other plastics, this situation could change. Even in Seattle where the "all rigids" program is several years old, however, the quantities of non-bottle and #3-7 plastics are low compared to PET and HDPE bottles. Furthermore, since plastics markets are international, it is unlikely that increased supply from King County would create a sizable new market opportunity.
- **Markets for mixed rigids improve when PET or HDPE bottles are included, making a #1-7 bale.** To reduce processing costs, some recyclers in the Northwest have switched to marketing mixed bales with some success. In King County, Rabanco/Allied has made this switch, but other handlers or processors report continuing to market PET and HDPE bottles separately. Rabanco/Allied reports receiving $0.09 to $0.12/lb for these mixed bales, but has had some recent troubles moving bales after feedback from Chinese buyers about the high fraction of the #3-7 plastics.
- **Asian trade regulations may impact the marketplace**. Asian countries, especially China, have expressed renewed concern over the quality of imported recyclables, citing landfilling costs and environmental pollution due to below-grade recyclables. For example, as of January 1, 2004, China began stricter enforcement of imported mixed paper. It is unclear whether this policy will extend to plastics, particularly these mixed rigid containers, in the near future.

Film

Plastic film recycling – including stretch film, shrink wrap, plastic bags – has grown rapidly in the Pacific Northwest in the last several years, and a large supply of the material has come from King County. Boise Building Solutions' (a division of Boise Cascade) new composite siding facility, which was in its early stages at the time of the 1998 *Markets Report* (Cascadia, 1998), may start selling products in the next year. Until technical issues recently delayed its plans, Boise was commanding a large share of the supply of the plastic film from King County. Trex, which manufacturers another lumber product using plastic film, has also increased its Northwest presence, resulting in high prices and healthy competition for film in the region.

- **Trex seeks to become more competitive.** Trex has long been a buyer of plastic film throughout the West Coast, but it has faced some difficulty remaining competitive locally, due to its relatively stringent material specification needs. However, Trex is now running a pick line that has enabled the company to accept film from sources that they previously would have avoided due to moisture or contamination concerns. This change may allow them to buy film from curbside recycling programs – a

supply that Trex has avoided since 2000, when it stopped buying material from Allied/Rabanco's Third & Lander facility.

- **The Boise "HomePlate" facility in southwestern Washington is slated to begin regular production in 2005.** After years of research, product development, equipment testing, and facility trials, Boise's siding facility near Elma is planning to bring its HomePlate product to market in the next year, though the plant temporarily halted sourcing materials in April 2004 due to technical issues. HomePlate is a composite siding board made of 50% recycled polyethylene film and 50% recycled urban wood. HomePlate is designed to occupy a unique market niche as a product more desirable than vinyl or aluminum because of its quality and paintability, yet cheaper and more durable than wood. HomePlate siding is also expected to be price competitive with concrete fiberboard siding when installed, due to the easy installation of its long, dimensionally stable, consistent boards. If successful, Boise's operations could provide a stable end market for recovered plastic film and urban wood for the foreseeable future (Horne-Brine, 2004; Just, 2003).

Prices

Prices for recycled plastics are generally as good as they have been in the past five years. These high prices generally represent strong demand and some degree of competition. Most notably, prices for plastic film are particularly high, as the advent of new remanufacturing technologies have kept buyers hungry – and competing – for more material. Following are more specifics on the pricing of baled material picked up in the King County region.

- **Prices for PET and HDPE are currently strong, but have had a turbulent history in recent years.** After highs in 1995, plastic prices bottomed out in early 1999, when both PET and HDPE were under $0.08/lb. A strong, consistent recovery lasted through late 2000, when prices began a steady decline reaching lows in the fourth quarter of 2001. After gradual improvement through 2002, prices began a dramatic climb, and they now stand at levels comparable to the highs of late 2000, with PET selling for $0.12 - $0.16/lb, natural-colored HDPE selling for $0.12-$0.14/lb, and colored HDPE selling for $0.05-$0.07/lb or higher.
- **Other mixed rigids have been selling for about half a cent per pound.** In most cases, recyclers are just happy to get rid of their other rigids (rigid plastics other than PET and HDPE bottles), as in recent years there sometimes have been no paying markets.
- **Baled plastic film is selling for $0.05-$0.08/lb.** Trex and Marathon both offer prices in this range to commercial generators with significant quantities. However, some low-quality film from residential curbside programs sells for less than one cent per pound.

9.3 BARRIERS & OPPORTUNITIES

Following are key barriers and opportunities regarding plastics recycling in King County.

- **Few markets exist for rigid plastics other than PET and HDPE bottles.** Domestic markets for #3-7 and non-bottle PET and HDPE are few and far between, and all or nearly all recyclers in the Northwest export this material to Asian markets for extremely low prices.[28] Recyclers rarely know what the material is used for, and some are concerned that the end users pick only a few resins out and discard or burn the rest. Thus, there appears to be a pressing need for market development for mixed rigid plastics.
- **Quality of PET and HDPE is a major concern for domestic markets.** PET and HDPE sent to the only regional domestic plastic reclaimer must compete with much cleaner material from Canada. This reclaimer reports that the conversion in Washington from source-separated to commingled recycling (in which glass may still be collected in a separate bin from other combined recyclables) has affected the quality of material they get, and that the introduction of single-stream (in which glass is collected in the same bin as all other materials) is expected to have an even greater impact. In particular, Merlin reports that fine, sand-like particles of glass are already contaminating the plastics and causing tens of thousands of dollars per year in increased screening costs alone. New technology or processes at the reclaimer may be able to handle many of the issues, but consumer education and improvements at MRFs may also be needed.
- **As fewer plastics are hand-sorted, opportunities may emerge for other solutions, such as technology.** Two factors have combined to decrease the cost-effectiveness of hand-sorting: 1) the increasing array of plastics collected that must be sorted; and 2) the increasing cost (relative to other options) of sorting. As a result, some recyclers are choosing to market mixed bales of plastics (including PET and HDPE) to Asian buyers rather than sort and market the individual resins. This trend indicates an opportunity for a technological or other solution that could sort, clean, and/or grind the plastics locally to retain or add value to the material.
- **An opportunity exists to increase supply, as recycling rates for plastic bottles are slumping.** Nationally, recycling rates for plastics (particularly PET) are slumping, and data indicates the same may be true in King County. One of the biggest contributors to this trend is the increased prevalence of single-serve soda and water bottles, as the

[28] Some recyclers in the Northwest sell this material to Merlin Plastics in Vancouver, B.C., but our contact at Merlin reports that the company resells these plastics to Asia.

growth of these items in the economy has not been matched by a growth in recycling.

- **Companies continue to explore creative uses for other rigid (#3-7) plastics.** Several products using mixed rigid plastics have been tested and trialed in other parts of the country in recent years, such as a lightweight aggregate made with fly ash and melted plastics, asphalt cold patch, and a Portland cement product. In particular, a business in Massachusetts has been successfully producing and selling lightweight concrete wall blocks using Portland cement where ground plastics has been substituted for the rock aggregate (Chelsea Center, 2002). Still, there is little national precedent for establishing profitable businesses using #3-7 plastics.

9.4 PUBLIC SECTOR OPTIONS

As the above discussions indicate, prices for plastics are high, but recovery rates for bottles appear to be sagging. This may seem a paradox, because for some other recyclable materials – such as metals and paper – upswings in market prices generally lead to higher recovery rates, as private sector recyclers pursue profits by increasing recovery. Plastic bottles, however, are lightweight and are highly distributed throughout the economy; as a result, profitable collection efficiencies are rarely attainable. Efforts to increase plastic bottle recovery rates must therefore often rely on education, incentives, technology improvements, or mandates.

- **Explore options to boost plastic bottle recycling, particularly individual serving PET bottles.** As plastics recycling rates fall, new strategies may be needed. A particular challenge is increasing recycling of single-serve PET bottles that are often consumed out of the home, where recycling services may not be as convenient. Education campaigns would likely help, but additional solutions – such as increased public place recycling, recycling mandates, disposal bans, or product stewardship approaches – may be needed.
- **Conduct initiatives to increase plastic film recycling.** Such efforts could include providing facilities and incentives for plastic film recycling at King County transfer stations, as resources and site improvements allow, and encouraging plastic film recycling at private transfer facilities. Programs in California may provide useful models. King County could also implement a promotion campaign, potentially in partnership with the private sector, to build awareness among commercial generators of plastic film recycling opportunities. Additionally, the County could promote plastic bag take-back programs, in which residents return their used grocery sacks and merchandise bags to their nearby grocery or drug store for recycling.
- **Form a team to investigate new sorting technologies.** Economic concerns are increasingly driving recyclers to sort less and export more.

If smaller processors and domestic end markets are to compete, new sorting solutions will be needed. Experience in British Columbia has indicated that government involvement can help identify and demonstrate the feasibility of new sorting technologies (Anderson, 2003).

- **Study the effect of single-stream recycling on plastic markets.** Although glass contamination from single-stream and commingled collection and processing of recyclables is most often cited as a concern for paper markets, one large domestic reclaimer of plastics noted that small, sand-like particles of glass are a great concern for his operation.
- **Develop a proactive approach to non-bottle and #3-7 plastics.** Plastics other than PET and HDPE bottles have limited, low-value markets. Efforts in other areas have focused on investigating the feasibility of producing new products from this material, with limited success. King County could take a couple approaches with this material stream:
  - **Team with other governments to study the feasibility of new uses for mixed rigid plastics.** In particular, a study could explore products successfully made and marketed elsewhere from non-bottle and #3-7 plastics and determine the feasibility of such operations in King County or the Puget Sound region.
  - **King County and its partners could also explore a product stewardship approach to encourage alternatives to #3-7 plastics.** In many cases, packaging made with plastics other than PET or HDPE could be made with more readily recyclable materials. King County could partner with other stakeholders to explore the feasibility of beginning to shift the marketplace away from these items to more recyclable alternatives, such as PET or HDPE.

9.5 REFERENCES

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Additional interviews with industry members who preferred to remain confidential.

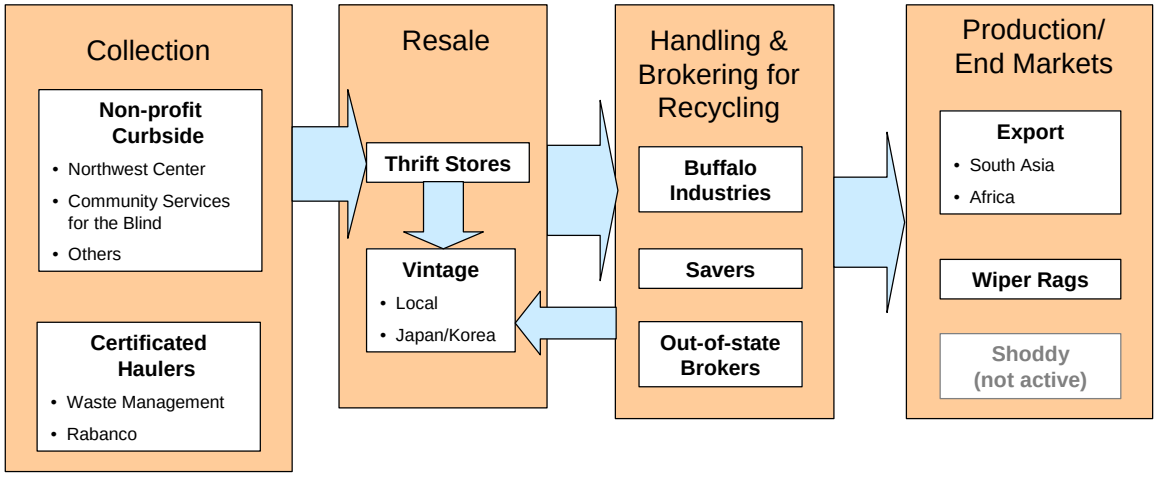
Chapter 10
Textiles

10.1 INTRODUCTION

For the purposes of this study, textiles include clothing, rags, curtains and other fabrics. Items such as carpets, upholstery, shoes and other leather items were beyond the scope of this study, although we will include any limited information that was provided by textile recyclers regarding these items.

Used textiles generated in King County come primarily from the residential sector. Once donated, items are generally either resold locally or shipped to third-world countries. The following chart displays the flow of used textiles in King County.

Figure 10-1. Current Supply Chain for Recycled Textiles Generated in King County



The following sections describe the current market conditions for used textiles, and the opportunities to improve the markets.

10.2 MARKET CONDITIONS

The last five years have seen several gradual shifts in textiles markets. For one, prices have recovered somewhat from their crash in the late 1990s, as demand has increased. But the rise in prices has not been enough to support the level of sorting and grading that previously occurred locally (or in neighboring Canada), given the emergence of overseas companies that will provide these services at much lower costs. Thus, the biggest change in local textile recycling is that much

less grading and sorting is occurring locally. The following sections provide further discussion of these and other related market conditions.

Supply

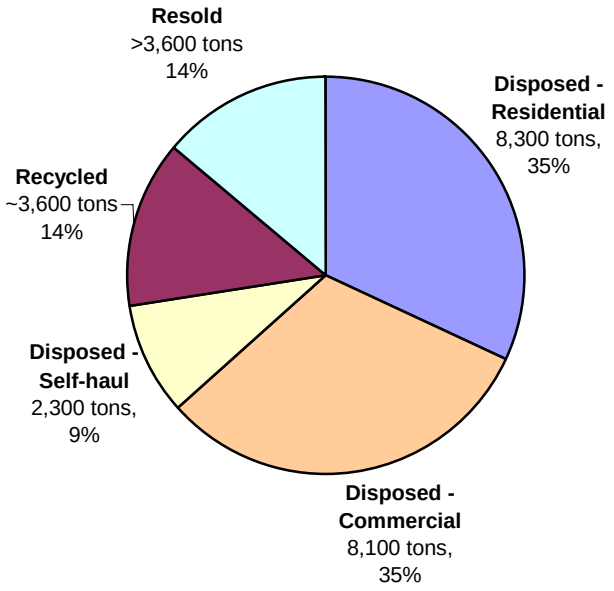
The largest quantities of used clothing and other textiles recovered from King County are donated by residents. Residents generally either have the option of taking material directly to thrift stores or drop-off centers, or having one of several non-profit organizations pick up material from their homes. From there, donated material is either resold locally or is handled by a textile broker or processor for sale into another market, usually overseas. Following are key findings regarding the supply of used clothing and textiles in King County. Note that in the discussions that follow, we will use the term *resold* (or its derivatives) to discuss used items that are sold locally, and use the term *recycled* to discuss used items that are sent to other markets.

- **Non-profits offer curbside collection services to acquire supply and help fund their programs.** For example, Northwest Center and Community Services for the Blind both pick up clothing from residents and sell them to Value Village stores.
- **The entry of local governments and waste haulers to the textile collection business is seen as a threat by many local non-profits.** Local non-profits and processors/brokers report that there is currently a delicate balance in the marketplace, where all parties are protective of their supply pathways, particularly in the relatively wealthy Eastside cities. In Kirkland, Waste Management teamed up with the non-profit Northwest Center to offer curbside collection of textiles. However, due to political pressure from other non-profits (as well as low volumes), the relationship ended in December 2003. Waste Management is still offering the collection service, but it remains to be seen how this program and the textile collection in Redmond (also via Waste Management) and Bellevue (offered by Allied/Rabanco) will further affect the non-profits, retailers, and processors/brokers.
- **Supply from King County peaks in the summer**, as residents clear out their storage and closets (Benezra, 2003).
- **An estimated 3,600 tons of used clothing were recycled from King County in 2002.** Thrift stores generally send items they cannot sell or overstocks to brokers or processors, who generally market them overseas.
- **An additional unknown quantity of clothing – likely at least as much as was recycled – was resold at retail stores.** Thrift stores generally do some sorting or culling of the clothing they receive. Saleable items are put on the store racks, while other material is passed on to brokers or processors. Items that remain unsold on the racks for too long are also sent to brokers or processors.

- **An estimated 140 tons of shoes, belts, and purses were recycled from King County in 2002.** These items are generally handled separately from clothing.
- **King County residents dispose an estimated 8,300 tons of textiles each year.** These items include clothing, rags, curtains, and other fabrics. King County businesses dispose an additional 8,100 tons of textiles, and self-haulers bring an additional 2,300 tons of textiles to waste facilities for disposal (Cascadia Consulting Group, 2004).

Figure 10-2 summarized the quantities of material that are disposed and recycled from King County. Note that the portion of disposed material that is potentially resalable or recyclable is unknown, and that the quantities that are presently recycled or resold are estimates based on conversations with several collectors and processors.

Figure 10-2. King County Textiles Recycling and Disposal



Processing & Infrastructure

Once items are donated, thrift stores or other clothing resellers generally sort them to determine what may be saleable on the store's racks. Other items (and those that have been on the racks but did not sell) are generally sold to processors or brokers. Following are more specific findings regarding the infrastructure that processes used clothing and other textiles from King County.

- **Goodwill, Value Village, Salvation Army, Shop & Save, and St. Vincent de Paul are the largest resellers** of used clothing in King County.

- **About half of donated clothing is resold locally.** One large local non-profit thrift store chain reports that about 50% of the clothing, linens, and shoes they collect are resold retail. The remainder of the material is either disposed, if it is low quality, or sent to processors or brokers.
- **Disposal of donated textiles has reportedly declined, but is still significant.** Local disposal of used textiles has reportedly declined, as a wider range of textiles are now marketable to south Asian and African markets. However, stained or ripped items are still generally disposed.
- **Two main processors/brokers are located in the region: Buffalo Industries and Savers.** These companies buy surplus or unwanted clothing from the non-profit thrift stores and other sources. Savers, the parent company of Value Village and Shop & Save, has its corporate headquarters in Bellevue. The Savers facility in Fife (in Pierce County) is the company's textile recycling facility for most of the western United States. Buffalo Industries, located in south Seattle, has no direct affiliation with any local retail outlets, including the similarly named – but unrelated – Buffalo Exchange.
- **Local grading and sorting of used textiles has declined, leading to marketing of more mixed bales.** In years past, companies such as Buffalo Industries and Savers were able to grade, or sort, clothing into as many as 120 different grades for export. Markets can no longer support the labor required to do this sorting, so processors report selling more mixed bales. The bales are often sorted at the end markets, which are generally in poor countries with low labor costs. The exception to this trend is the growing local and Japanese vintage markets (see below), but these markets handle only a small fraction of the textiles handled by the two major processors.

End Markets & Prices

The vast majority of recycled textiles are sold overseas, where buyers value the quality and price, as well as the symbols of American culture. South Asia and Africa are the largest markets. Following are more specific findings regarding the marketing of recycled textiles collected from King County.

- **Most recycled textiles, if not resold locally, are marketed overseas.** Non-profits and other local organizations generally sell their surplus or unsold items to one of the two local processors/brokers, Savers and Buffalo Industries. Some organizations send their clothing to other, out-of-state brokers or regional consolidation points, where it is then marketed to other countries. Textiles marketed overseas are generally sold by the pound in 1,000-pound bales.
- **Markets for vintage clothing are strong, and demand has been increasing.** Processors/brokers are able to sell a small but valuable fraction of the clothing they receive to overseas vintage retailers, or in some cases back to local vintage retailers. The number of local vintage

retailers has increased in recent years, supplementing the already-strong Japanese and Korean markets. However, local vintage stores reportedly purchase or consign a large fraction of the clothing they sell directly from the public.

- **By volume, South Asia and Africa represent the largest demand for recycled clothing.** Contacts report that India and Africa are the largest markets. Prices are often higher in South America, but so are the standards. Demand for clothing from overseas markets varies seasonally, but it is generally highest during the summer in the destination country.
- **End markets face competition from cheap new clothing, often produced in Asia.** The increased production of low-cost items from China and other Asian countries has increased competition for overseas consumer dollars. This competition limits the growth of used textile sales. However, not all contacts report that this is a problem, as end markets are often more interested in used American clothing than in new, low-quality Chinese imports.
- **Used clothing competes overseas on quality and price.** Used clothing is often in high demand for its quality and price. In addition, the spread of American pop culture has led residents of many countries to desire clothing bearing logos or symbols of American sports teams, companies, or icons. This situation has created controversy as traditional garments have been losing ground to imported, used clothing.
- **Some countries ban the import of used clothing.** Such bans are often intended to protect local garment manufacturers.
- **Textiles that enter the "wiper rag" market are generally acquired from post-industrial sources.** Companies that make these wiper rags for auto shops and other uses generally buy pre-consumer remnants from brokers or manufacturers. Little, if any, post-consumer clothing is used to make wiper rags.
- **Local brokers/processors no longer market to the "shoddy" industry.** Textiles generated in King County are no longer sold for shoddy – finely ground textiles used primarily as fill (or "fluff") in automotive seat cushions or other padding. What used to be sold for shoddy is now generally included in the mixed bales marketed overseas. Companies that traditionally have used shoddy from recycled textiles are increasingly using virgin synthetic fibers to meet their needs (Chelsea Center, 2002).

Prices

Prices for recycled textiles crashed in the late 1990s due to an economic collapse in Asia, but have generally recovered. Still, prices for recycled textiles can fluctuate greatly. Following are the current range of prices reported by local textiles collectors and recyclers.

- **Processors/brokers purchase used clothing from local non-profits by the pound.** Prices are generally on the order of $0.05 per pound, but they can vary depending on the quality.
- **Processors/brokers generally sell vintage items by the piece, not pound.** These items can command up to several dollars per item.
- **Processors/brokers sell non-vintage clothing for anywhere from $0.05 to $0.12/lb.** Prices vary depending on the market and the quality of material.

10.3 BARRIERS & OPPORTUNITIES

- **The relatively poor economics of textile recycling limits growth of the industry**. The last few years have been difficult for local textile processors and brokers, as the prices they received generally could not support the labor required to sort or grade the material. As a result, the companies now sell mixed bales overseas, and have had to compensate for lower prices by increasing throughput. Processors/brokers are generally able to move material, but balancing seasonal demand and supply can be difficult.
- **However, significant quantities of textiles are still disposed, suggesting a possible opportunity to recover more material.** In addition, it may be possible to move more material into the growing higher-value vintage and high-end resale market available locally and in Japan and Korea.
- **The decline of the shoddy market suggests a possible opportunity for use of this feedstock**. Textiles can be used to make shoddy, a nonwoven product that can be used in a variety of applications requiring absorbent, cushioning, insulating, or sound-deadening material. The automotive industry, formerly a large market, may still be a possibility, as could potential "green building" applications where recycled content is valued. However, most of the material formerly used as shoddy is currently exported in mixed bales, and recyclers report that there is little economic incentive to sort it out. Material for shoddy could also be acquired directly from thrift stores, who report disposing of soiled or damaged clothing, rather than from recyclers.

10.4 PUBLIC SECTOR OPTIONS

As described above, the local used textile collection industry is highly protective of its supply pathways. As such, most players have viewed the recent partnerships of local governments with Waste Management as a threat. Nevertheless, King County is interested in maximizing recycling in the county, and in ensuring strong markets. The following opportunities could be explored to advance textile recycling and help determine the future role of local governments in textiles recycling.

- **Characterize textiles that are still disposed and assess opportunities for moving them into the reuse or recycling marketplace.** Waste composition data indicate that nearly 19,000 tons of textiles are still disposed annually from King County outside Seattle (Cascadia Consulting Group, 2004). According to the definition of textiles in the study, these items may be clothing, rags, curtains, or other fabrics. However, the relative percentage of each of these items in unknown, as is the condition of the items and therefore their marketability. This lack of data makes it difficult to assess the success of the current system of textile collection and recycling. As part of its next waste composition study or as a separate study, King County could gather more detailed information on the different types and conditions of textiles being disposed.
- **Conduct further research on the costs and benefits of curbside textile collection by waste haulers.** Preliminary results from the City of Kirkland's program indicate low volumes, logistical challenges with the trucks, vocal opposition from certain stakeholders, and delicate market dynamics. Yet proponents argue that textile collection by waste haulers taps a stream of material that would otherwise be disposed. While there is not yet enough information to make a judgment on the net benefit of this service, there are clearly both pros and cons. King County could conduct a study on the advisability of curbside textile recycling and make recommendations to local governments with solid waste and recycling contracting authority. One key area of information might be the quantity of marketable textiles still in the waste stream, as discussed above.
- **Consider education and/or incentives for reusing and reselling clothing.** The highest-value market for used textiles is local resale. King County could consider aiding the development of local resellers of used clothing, including thrift stores, vintage, "upscale resale," and other used clothing stores. Possible options to consider might be financial incentives to stores, marketing assistance to help stores expand their customer base to new demographic groups, or public education and promotion of the economic, environmental, and social (or stylistic) benefits of purchasing used clothing.

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Chapter 11
Wood

11.1 INTRODUCTION

This chapter focuses on recyclable urban wood, including dimensional lumber, engineered wood, manufacturing scrap, pallets, crates, and other wood materials. For the purposes of this study, recyclable wood excludes creosote- and pressure-treated wood, painted or stained wood, mixed wood from demolition, and a portion of wood roofing and siding that is assumed to be unrecyclable.[29]

Once wood enters the waste stream, the activities that generated the material (e.g., demolition, manufacture, or warehousing) are not readily discernable. Accordingly, the findings and recommendations included in this chapter cover recyclable urban wood, which may have its origins in construction and demolition (C&D) activities as well as non-C&D sources. Wood generated from land-clearing activities is not included in this analysis, as these materials typically have different markets than most urban wood.

King County recently conducted a *Market Assessment of Construction and Demolition Waste Materials*, including wood. This chapter provides a brief summary of key information from that study, but interested readers can refer to the complete report for additional details.

11.2 MARKET CONDITIONS

This section summarizes key market conditions – including supply, processing and infrastructure, end markets, and prices – for recycled wood from King County.

Supply

Most of the urban wood from King County that is suitable for recycling is currently recovered, mainly as source-separated materials. More than 70,000 tons of recyclable wood remain in the waste stream, however, representing a sizeable opportunity for increased recovery. The section below describes current and expected future supplies of recyclable wood in King County.

- **Most recyclable urban wood is currently recycled.** An estimated 194,000 of the 267,000 total tons of recyclable urban wood generated in 2002 are recycled, for a 73% recycling rate (Cascadia, 2003).

[29] Note that many hog fuel burners can accept wood with some contaminants, such as lead-free painted or stained wood; however, such materials are generally not appropriate for higher-value uses and typically are not considered recyclable.

- **Most of the recycled wood is source-separated.** At least 169,000 tons of the 194,000 tons of wood recycled was source-separated, with a relatively small fraction being sorted from commingled loads at Recovery 1 in Tacoma (Cascadia, 2004). Anecdotally, the fraction of recyclable wood flowing to Recovery 1 decreased in late 2003, coinciding with the opening of the Rainier Wood Recovery plant in Auburn (see below for more information on this development.)

Current Supply

Table 11-1 summarizes the quantities of recyclable wood that King County generates annually. As shown, the total supply of urban wood in King County (excluding Seattle) is approximately 320,000 tons, of which more than 80% is considered recyclable. Of the 267,000 tons of recyclable wood generated each year, about 73% is actually recovered from the waste stream for recycling.

Table 11-1. King County Recyclable Wood Generation, in Annual Tons
(excludes Seattle)

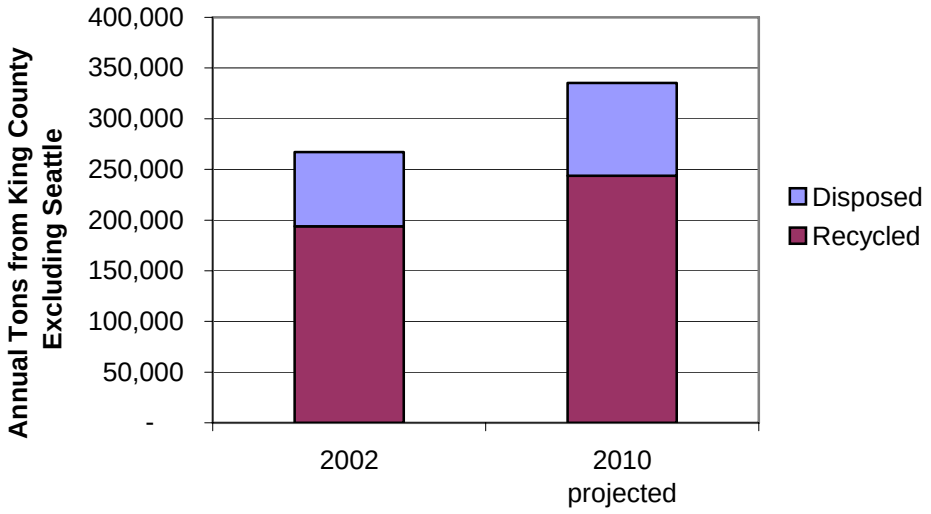
	Disposed	Recycled	Total Generated	Recycling Rate
Recyclable urban wood	73,000	194,000	267,000	73%
Non-recyclable urban wood	53,000	-	53,000	0%
Total urban wood	126,000	194,000	320,000	61%

Projected Supply

Wood generation in King County is expected to increase in the coming years as population rises and economic activity grows. Based on econometric modeling that the King County Solid Waste Division conducted, we have projected a status quo future where wood generation increases while the recycling rate remains constant. Projections from Solid Waste Division staff predict that the county will generate approximately 26% more waste in 2010 than it generated in 2002 (Rist, 2003).

Figure 11-1 displays this expected increased in generation of recyclable wood. Note, however, that this projection does not account for any potential policy changes or other efforts to increase wood recycling.

Figure 11-1. Total King County Recyclable Wood Generation: Current and Projected Status Quo
(excludes Seattle)



Processing & Infrastructure

Most of the urban wood recovered for recycling has traditionally come from source-separated loads, though the Recovery 1 facility in Pierce County recycles some wood from commingled loads of construction and demolition (C&D) waste. The biggest development in the urban wood marketplace is the recent opening of a new facility in Auburn designed to process clean recycled wood for manufacture into a composite siding product. The new siding is not yet available, so its reception in the marketplace will be a major influence on future recovered wood processing in the region. The following items summarize processing and infrastructure for recyclable wood in King County.

- **In 2003, Marathon Recovery and Rainier Wood Recyclers opened a new processing facility in Auburn.** Their joint operation has a contract with Boise Building Solutions (a division of the Boise forest products company, formerly Boise Cascade Corporation) to provide approximately 100,000 tons of wood per year for Boise's new composite wood/plastic siding facility near Elma in southwestern Washington. The Marathon/Rainier plant is expected to be a major player in the region's wood recycling infrastructure. The facility is able to process about two-thirds of the material it receives to Boise's specifications, with the remaining third – mostly fines and wood pieces too small for siding manufacture – sold to the hog fuel market for combustion. In late 2003, Marathon/Rainier sent 25,000 tons of urban wood to Boise Building Solutions, but in April 2004 it stopped sending wood due to technical issues at the Elma plant. If the Boise plant starts production as expected in 2005, Marathon plans to increase its wood sourcing to 12,500 tons per

month, or 150,000 tons per year, when the plant reaches full production. Marathon's primary suppliers include large and small pallet collectors as well as commercial sources such as lumberyards, cabinetmakers, and industrial users (Horne-Brine, 2004; Just, 2003). More information on Boise's composite siding manufacturing appears in the following section on *End Markets & Prices*.

- **Some transfer stations also accept source-separated clean wood for recycling.** The privately operated Black River, Third & Lander, Eastmont, and Recycling Northwest facilities, as well as King County's Enumclaw site (and the City of Seattle's two transfer stations), accept clean wood for recycling. Some of this wood is then sold to the Rainier/Marathon facility in Auburn.
- **Recovery 1 processes commingled C&D loads.** Recovery 1 recovers wood from commingled C&D loads. The opening of the Rainier/Marathon facility in Auburn, however, will provide an increased incentive for generators to source-separate large quantities of wood, and the quantities of wood delivered to Recovery 1 will likely decrease.

End Markets & Prices

Hog fuel – ground wood chips that are burned as fuel in biomass boilers – has traditionally been the primary end market for wood recovered from the urban waste stream, but that situation may change with the development of Boise Building Solutions' HomePlate wood/plastic siding product. If the product proves successful, its manufacture should provide a stable end market for recycled urban wood and plastic film for the foreseeable future. In terms of other markets, pulp chips are no longer a viable end market for urban wood, and local mills discontinued their use in recent years due to contamination and other production problems. Compost and landscaping remains a small market for urban wood. The following section provides additional information on end markets for King County's recycled wood.

- **Wood/plastic composite lumber offers a potential new, large, and growing market.** Boise Building Solutions' new wood and plastic composite lumber facility in Elma is expected to demand approximately 100,000 tons of urban wood annually if operating at full capacity. While this material will be sourced throughout the region from Vancouver, B.C., to Portland, Oregon, King County's urban wood will be a crucial supply, as the Rainier/Marathon processing facility is located in Auburn. The facility accepts the higher grades of wood (including pallets, crates, mill-ends, and dimensional lumber) at no charge. For lower grades of commingled material, the facility charges a tip fee of up to $20/ton. Despite previous forecasts of a slowdown, the Northwest housing market continues to rise, suggesting robust construction and remodeling activity to consume these new building products when they become available.

- **Boise is poised to introduce its HomePlate siding to the market.** The manufacturing facility is currently working on technical difficulties, but Boise plans to produce its new siding for residential construction beginning in 2005. HomePlate is a 100% recycled composite clapboard siding material consisting of half recycled urban wood and half recycled polyethylene film. Boise expects that HomePlate will be more attractive than vinyl or aluminum to many builders and homeowners due to its quality and paintability, while it remains less expensive and more durable than wood. Its dimensional stability and length (16 feet) will facilitate installation, and its price when installed should be comparable to concrete fiberboard. The company has invested millions of dollars in this venture and plans to open more plants if the current one proves successful.
- **Hog fuel has been the dominant market for recycled wood.** The hog fuel market, in which ground wood chips are burned as fuel in biomass boilers, has claimed over 80% of the recycled urban wood from King County. While the Boise facility is expected to claim much of the higher-quality urban wood when it resumes production, hog fuel markets are predicted to remain strong, particularly for lower-quality wood. The hog fuel market pays $8 to $20 per *bone dry* ton. Moisture content of wood varies, but assuming a 25% average, these prices are equivalent to $6 to $15/ton.
- **The once-promising pulp market for urban wood is no longer viable.** In the 1990s, pulp was viewed as a promising emerging market for urban wood, but the crash of the pulp and paper markets in 1996, coupled with the resulting industry restructuring, has kept pulp from materializing as a practical end market for recovered urban wood. As of December 2002, local pulp mills discontinued their use of pulp chips from urban wood. Previously, Longview Fibre was the only buyer, but the company has since decided that the problems with urban wood, including contamination and limited suitability for their current pulping process, were too serious to continue its use.
- **Compost and landscaping is a small market.** Urban wood is sometimes used as a bulking agent in compost production or ground, chipped, or shredded to make landscaping mulch. End users in this market utilize about 8,000 tons per year.

11.3 BARRIERS & OPPORTUNITIES

Though promising new markets for recycled urban wood are emerging, recycling still faces several barriers, including quality, transportation costs, and competition from virgin materials. The following barriers affect markets for recyclable wood in King County.

- **Contamination limits the end markets that use recycled urban wood.** Metals, paint, and other materials can contaminate wood supplies, especially from streams that are not source-separated. Such contamination can damage processing equipment and reduce the quality of finished products. For example, pulp markets no longer accept recycled urban wood, due to contamination and incompatibility with current processes and equipment.
- **Source-separation of urban wood can be time-consuming, but few facilities can process commingled materials.** This situation can make it difficult for end users to source and maintain a stream of clean wood suitable for higher-value uses, such as for new building products.
- **Limited recycling options can increase transportation costs and discourage recycling.** King County lacks a processing facility, akin to Recovery 1, that is capable of recovering a high proportion of recyclable wood (and other materials) from commingled loads. As a result, wood generators and haulers have to travel significant distances to recycle mixed loads. (Waste Management's Eastmont and Woodinville facilities sort clean wood and some other materials from waste loads, but they are not full-scale commingled processing operations like Recovery 1 in Tacoma.) The establishment of a local commingled processor would make wood recycling more convenient for generators and haulers. Even for source-separated wood materials, the limited locations of recycling facilities can increase transportation costs for recyclers – or make disposing of the material at a transfer station appear more attractive than recycling.
- **The ease of use and low prices of other materials can make it difficult for recycled urban wood to compete in certain end markets.** For example, virgin wood residues are the primary feedstock for particleboard. Forest thinning and fast-growing tree species can supply inexpensive virgin material for the production of engineered wood products. Washington has no manufacturers of reconstituted panelboard, including particleboard, hardboard, and medium-density fiberboard (MDF). Such facilities exist in Oregon, but transportation is costly, and their use of urban wood is extremely limited due to concerns regarding quality and compatibility with equipment. In contrast, HomePlate siding is specifically designed to use urban wood, and the manufacturing process takes advantage of the dryness and particle size of this feedstock. Production is currently delayed until 2005, however.

Opportunities for enhancing markets for wood recycling include both supply-side and demand-side options, as described in the following list.

- **Increase recovery of urban wood.** Large quantities of recyclable wood currently being disposed represent an additional supply for future increases in recovery. Rising market demand and reports from processors suggest that end markets could handle additional wood supply if it was available.
- **Encourage higher-value end uses for recycled urban wood.** Higher-value markets – such as building products instead of hog fuel – could increase market diversity, competition, and stability for recycled wood. Such a shift should also lead to higher prices paid for recovered materials and resulting increases in financial incentives for recycling. Boise's HomePlate **siding** plant represents such a potential high-value end use, and with success it could become a linchpin in the recycled wood marketplace. Washington's five manufacturers of **finger-jointed wood** – in which small pieces of timber are joined to form longer members – represent another opportunity for higher-value use, but insufficient quantity and quality have been barriers to date for using urban wood. **Reconstituted panelboard** offers potential higher-value products, including **particleboard**, **hardboard**, **medium-density fiberboard (MDF)**. However, the location of regional manufacturers in central Oregon, coupled with contamination problems associated with urban wood, make panelboard unlikely to provide a viable end market for recycled wood.
- **The hog fuel market has few constraints on the materials it can accept.** Hog fuel remains available as an alternative to disposal for wood waste, as transportation cost is the main barrier to use in this market. Use of recovered wood for energy production, however, is only one step above disposal on the waste reduction hierarchy, and hog fuel remains a low-value end use with debatable environmental implications.
- **Urban wood can be used as a bulking agent in compost production.** Only a limited amount of wood is needed in the composting process, however, and significant supplies come from other sources, such as land-clearing activities. This market may need additional wood with increased composting of organics, particularly if food waste collection becomes more common. Bulking agents, however, remain a low-value end use for recycled urban wood.

11.4 PUBLIC SECTOR OPTIONS

From the opportunities identified in the previous section, King County and other public-sector entities have several opportunities to improve market conditions for recycled urban wood, as outlined below.

- **Increase recovery of recyclable urban wood.** Several options exist for raising the supply of urban wood available to end users:
  - **Encourage self-haulers and commercial operators to take their wood waste to a recovery facility.** King County could potentially conduct a promotional campaign in partnership with local wood recyclers.
  - **Provide economic incentives for generators to source-separate urban wood.** Higher tip fees at transfer stations on loads containing a high percentage of recyclable wood could encourage increased recycling.
  - **Encourage wood recycling at transfer stations.** Provide free or reduced tip fee opportunities for wood waste recycling at King County transfer stations, as resources and site improvements allow. Also, use the contracting process to encourage private stations to provide for recycling of high-grade wood.
  - **Ban the disposal of wood waste.** Such a disposal ban would require generators to reduce, recycle, or find other options to handle their wood waste.
- **Assist with the establishment of a commingled processing facility, similar to Recovery 1 in Tacoma, in King County.** No such facilities currently exist in the county. (Waste Management sorts some wood from commingled loads at its Eastmont and new Woodinville facilities, but it does not recover a high fraction of recyclable wood.) A dedicated facility would make wood recycling more convenient for generators and haulers.
- **Investigate other higher-value end markets for urban wood.** The Boise siding product appears to be a promising end use for urban wood, and King County may be able to help this market grow. Other higher-value uses, such as finger-jointed wood products, may be possible, though use of recycled wood in a local reconstituted panelboard operation appears unlikely.

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