Beyond Waste
Washington State Solid Waste Plan

ISSUE PAPER 10

Solid Waste Costs And Barriers to Recycling

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This is a preliminary paper that will be used to further analyze and explore cost issues related to solid waste management in Washington. This paper does not reflect policy decisions of the Department of Ecology; rather, it identifies important issues to consider.

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TABLE OF CONTENTS

APPENDIX A: Single-Family Residential Curbside Recycling Case Study

APPENDIX B: Tax and Subsidy Barriers to Recycling and Sustainability

LIST OF TABLES AND FIGURES:

Executive Summary

The sustainability goal of the state solid waste plan recommends that Washington value our future waste as a resource, as opposed to considering it something to be disposed. Therefore, this issue paper builds on a conceptual description of sustainability and moves toward an understanding of how sustainability relates to solid waste management in Washington including current and alternative cost methods and recycling barriers.

Most solid waste managers in Washington use traditional cost-benefit analysis in their decision-making processes. Although it is common to use full-cost accounting methods that include external costs, future costs, and discount rates, not all decisions are made based on full-cost accounting. To make more informed decisions, solid waste managers can also incorporate external costs not captured by existing accounting practices. These external costs include pollutant emissions, depletion of natural resources and impacts on human health and the environment.

Life-Cycle Assessment (LCA) is a tool that can be used to evaluate traditional (internal) costs and benefits as well as external costs and benefits. LCA studies of solid waste systems have found that the most significant impacts of recycling are costs associated with the natural resource depletion and energy use for virgin materials extraction and manufacturing. LCA is an emerging policy tool that provides a way to connect solid waste practices and policy to sustainability.

Sustainability encompasses environmental, social and economic issues. Funding for recycling programs that is dependent on the volume of waste disposal is not economically sustainable. One main focus of this issue paper is to look at barriers to recycling. These barriers are identified as falling under the following categories: financial, regulatory, political, logistical, and community-based. Local, regional and state-wide coordination may be required to remove these barriers.

Decisions about how much and what type of recycling and other diversion should be provided in a given area can be better made after considering the following work:

- Gather more comprehensive life-cycle analysis of materials
- Consider the costs of solid waste using a more comprehensive model making use of sustainability principles
- Evaluate tools such as the Life-Cycle Inventory for use as a policy development tool for resource management
- Examine methods to internalize external costs
- Governments lead by example through purchasing recycled content products
- Use information to affect consumer and corporate behaviors, for example, by using LCA to demonstrate savings from cost avoidance

In a broader context, this paper suggests that the focus ultimately lies in creating products in manners that conserves natural resources, minimize waste, are compatible with biological processes, and limit the use of materials that create significant negative impacts on the ecosystem. Internalizing external costs will affect pricing signals in the market in such a way that costs would reflect what is and what is not sustainable.

Introduction and Purpose

The Washington State Solid Waste planning process was initiated in 2001 with the development of issue papers that discuss key policy issues. This issue paper was developed by a workgroup with interest in and/or experience with the topics included herein. The issue papers are intended to explore important solid waste issues and in most cases also call for further consideration, research, and discussion with the solid waste community.

At the outset of the state plan and issue paper identification process, two of the issue papers envisioned were combined as this single issue paper. Issue paper #8 was to focus on the barriers to recycling and issue paper #10 was to focus on the cost of solid waste management. Before the first meetings were convened it was agreed to combine these two issue paper efforts since the structure of solid waste cost analysis is an important factor in the effectiveness of recycling. Consequently, this issue paper contains information regarding barriers to recycling as well as a discussion of tax and subsidy barriers to recycling and sustainability presented in Appendix B. Due to this dual focus and other factors, a case study presented in Appendix A provides a first look at analyzing the policies around curbside residential recycling in Washington. This case study provides a limited examination of the traditional and more inclusive costs of solid waste management using a partial Life Cycle Assessment (LCA) analysis.

The sustainability goal of the state solid waste plan includes a directive to examine a concept that includes valuing our waste in the future as a resource, as opposed to considering it something to be disposed Therefore, this issue paper builds on a conceptual description of sustainability and moves toward an understanding of how sustainability relates to solid waste management in Washington including current and alternative cost methods and recycling barriers.

This issue paper provides a general discussion of how solid waste and recycling costs and benefits are currently developed. The role of the State Solid Waste Plan is to provide the impetus for making decisions and choices based on the principles of sustainability. Except where explicitly stated as Department of Ecology policy, no inference should be made with regard to the discussions and analysis contained in this issue paper. This issue paper, as with the other nine, was developed to explore specific topics of importance to the Department of Ecology and the state Solid Waste Advisory Committee. It does not create new policy.

Key Questions Provide a Starting Point for Discovery

To start to frame the discussion and to guide the process, the workgroup suggests considering some key questions:

- Does the present solid waste system support waste disposal over recycling and/or waste reduction?
- Is the present solid waste system sustainable, and how would we know?
- Does the present funding method for the current solid waste system create barriers to sustainability?
- Does the present solid waste system create barriers to recycling?

- How can the concepts and principles of sustainability be connected to the everyday realities of solid waste planning and management?
- How do we measure sustainability in the solid waste system?

This issue paper begins to look at these questions, provides context, and in some cases develops significant analysis in addressing these questions. In most cases there is a significant amount of further effort required to answer the key questions for the state or the whole solid waste system.

While the initial focus of this paper was to explore several issues within the solid waste management system, it has become apparent that the issues are larger than the solid waste system itself. The solid waste system receives waste products that are the result of countless decisions made by resource extractors; manufacturers; service providers; retailers; federal, state and local government; foreign governments; business; and consumers. The solid waste system therefore cannot fully solve its issues without also addressing larger societal concerns. In this light, the volume and type of solid waste becomes an indicator of unsustainable practices elsewhere in society. Issue paper 10 and its appendices have four primary purposes:

- Identify the economic factors that lead to waste generation habits that are not sustainable
- Identify the initial steps toward a potential course of action that may help the solid waste system to become more sustainable
- Identify specific barriers to recycling
- Provide a sample analysis of recycling costs and benefits using a partial LCA analysis

This issue paper is divided into three sections in addition to the appendices:

- Section 1: Economic Concepts for Changing Wastes to Resources
- Section 2: Moving from Economic Theory to Practice
- Section 3: Barriers to Recycling

Section 1:
Economic Concepts for Treating Wastes as Resources

Economic concepts are important for evaluating our residuals as resources rather than wastes, and for bringing issues regarding sustainability into the discussion about solid waste management choices. This section covers basic economic concepts currently used in solid waste management as well as alternative methods such as inclusion of "external costs" into the price of products and solid waste services. Unless we consider all costs and benefits of the solid waste system the price paid by our customers will not reflect the best use of resources.

Market Prices and Full Costs

According to traditional economic theory, goods and services used in the economy have prices that fully incorporate all costs related to their creation. The costs that are included in the price of a good or service are called "internal costs." Internal costs are reflected in market prices paid by consumers. Competition in the marketplace should lead to the most efficient use of resources and the lowest price for goods and services, as long as prices include all significant costs.

Internal costs typically include all transactions within the economic system that are tracked using standard accounting methods and practices. In the solid waste system internal costs include costs such as trucks, compactors, containers, landfill construction and maintenance, labor, utilities, administration, and environmental monitoring and control.

Internal costs are further divided into **fixed or variable costs**. Fixed costs do not vary significantly with the level of operating activity or production. Fixed costs include amortization on facilities and equipment, routine maintenance, and administration. Variable costs are typically proportional to the level of operating activity or production. Variable costs include costs such as operating-related maintenance, labor, and fuel.

Full-cost accounting is an accounting practice that includes all known and measurable internal costs and incorporates those costs into the market price.[1] This method includes future costs of the system; for example, landfill closure and post-closure would be included in a full-cost accounting price for a tipping fee.

In addition to funding traditional disposal, the Washington solid waste system includes other required programs such as education and outreach, toxicity and waste reduction, and recycling. These costs are not directly related to disposal activities but are typically supported by tipping fees. It is the goal of state and local governments to reduce disposal of MSW in favor of waste reduction and recycling. However, waste reduction programs reduce tipping fee revenue upon which most of these programs rely. This mismatch between waste generation revenue and toxicity and waste reduction expenses is a funding conflict in the solid waste system. Not all solid waste tipping fees incorporate the costs of waste reduction and other non-disposal programs. Full-cost accounting can help align the costs between the two required parts of the solid waste system.

Full-cost accounting provides a more sound basis than historic accounting methods used for decision-making in the solid waste system. However, full-cost accounting does not include external costs. The next section discusses how external costs can become internalized and the obstacles to and advantages of internalizing these costs.

In addition to using full-cost accounting for all internal costs, solid waste managers also need to consider **future costs** and the use of **discount rates**. Cost impacts of today's solid waste management choices may occur far into the future. A 1996 study of King County's Cedar Hills landfill provides an examination of future costs.[2]

In the 1996 Cedar Hills study, if solid waste management choices were made only on the basis of current year operating costs for disposal, $7 per ton in avoided costs would result from diverting waste from disposal. However, it is reasonable for the solid waste manager's time horizon and cost estimates to encompass the opening and closing of landfill cells, landfill improvements, final closure, and post-closure maintenance. Also, after Cedar Hills reaches capacity, King County expects to begin exporting waste, further increasing future costs. Waste diversion puts off the landfill's closure date. In addition to the avoided costs for future landfill construction and maintenance, waste diversion also delays the onset of long-hauling costs estimated at $38 per ton

Based on an assumption of a positive interest rate, one dollar spent today is more valuable than one dollar spent in the future. Discount rates are often estimated by calculating an expected interest rate minus an expected inflation rate. For example, if we assume an interest rate of 10% and an inflation rate of 3% we would have a discount rate of 7%. We use a discount rate to represent today's value of a dollar spent in the future. For example, a 5% discount rate implies a willingness to spend fifty cents today to save a dollar 14 years in the future. In the King county example using a discount rate of 5%, the $7 savings of avoided operating disposal cost becomes an estimated $16 avoided operating cost when future savings are included. Without including a discount rate the full-cost accounting would be incomplete.

External costs are costs that are outside the economic system and are not accounted for by traditional accounting methods and practices. For example, when a material is mined from the earth, some of the costs associated with the mining, such as temporary or permanent habitat loss and environmental pollution, are not paid in full by the mining company. Costs not paid by the producer of a good or service are not reflected in the market price of that good or service. Because natural resources such as a healthy habitat benefit all of society, everyone pays for the habitat loss, even those who did not benefit by purchasing the good or service.

There are examples of external costs that are quantifiable by keeping track of costs that are paid by individuals or organizations other than the producer of a particular product or service. For example, the U.S.D.A Forest Service builds roads into forests at taxpayer expense to provide access for logging companies to timber stands. The trees are harvested by the highest bidder, and sold by that bidder to recover their logging costs and profits. The cost of the road is not included in the price of the timber or in the price of lumber or pulpwood produced from the logs because the Forest Service does not recover the road building costs from the winning bidder. Thus, the cost of the road is an external cost. However, the Forest Service is able to track the cost of building the logging road and that cost is actually paid by tax dollars. Yet that cost is not included anywhere in the actual prices paid for the trees, or the products made from them.

There are also examples of external costs that are not so easy to quantify monetarily. Sometimes this is because the external cost is caused by a widespread environmental impact. For example, the health care costs of medical treatment for respiratory problems (such as asthma) that are caused by air pollutants are paid by those needing medical treatment (and their employers or health insurance companies), and not by those producing the air pollutants.

The environmental impacts from methane released into the atmosphere from landfills also generate externalized costs. Any global warming impacts from releases of such methane will be borne by future generations and not by the users of today's landfills; as such costs are not incorporated into disposal costs (tipping fess) charged to customers.

In all of these examples, the prices of products or services do not reflect all the costs incurred in the production of these products and services. When some of the costs of producing a good or service are not reflected in the market prices for those goods or services, the resources allocated to produce those goods and services will tend to be over utilized in making those items and underutilized for other purposes. That is, the resources will not be used as efficiently as they might be. This is because purchasers of goods or services that have significant external costs are not informed of those costs through the prices that are charged in the marketplace for such items. Thus, purchasers will buy more of these items (because of their low price) than they would if the items had higher market prices to cover their external costs. In turn, producers of these items are encouraged to make relatively more of the goods or services than they would if they had to charge higher prices to cover the external costs that they currently do not pay.

And so the cycle proceeds, with benefits to producers and users who haven't paid all the costs caused by the production of these goods or services, and costs to others who haven't received the benefits of using the goods or services. In this way, external costs distort the efficient allocation of resources in the market economy.

Modifying the Market Price: Internalizing External Costs

Full-cost accounting is a valuable first step, but it is not the final destination. Many important environmental effects are overlooked by a full-cost accounting system because they are not reflected in traditional market costs and resulting prices.

One way in which society has internalized an external cost is to create a **tradable permit system**. For example, sulfur dioxide emissions are regulated using a tradable permit system under the Clean Air Act. Theoretically, the free exchange of permits on the market establishes a price for pollutant releases. The tradable permit system establishes limits on the amount of sulfur that each generator can release, and at the same time allows generators to buy and sell permits reflecting amounts by which they are exceeding or failing to meet their emissions limits. The use of clean air is treated like any other resource for manufacturing goods and services. The factory's accountant can multiply tons emitted together with the market price for emission permits to calculate a cost for pollutant releases. To pay this cost the factory must charge more for their products to cover the additional cost of exchanging clean air for less clean air. There are real cost savings for facilities that emit less sulfur dioxide.

Another approach to internalizing external costs is through **emission taxes**. In the absence of markets for pollution releases, economic theory suggests that external costs can be accounted for by evaluating the costs imposed by pollution and requiring producers and consumers to pay for the damages that result from their actions. These emission taxes must be set high enough to raise enough money to cover external costs of pollution.

If all external costs were internalized, market outcomes would be efficient because all producers and consumers would be paying for all impacts caused by the production and consumption of the goods and services they use. The marketplace would demand only the amount of resource use and pollution that consumers are willing to pay.

In practice there are significant obstacles to internalizing external costs. The correct valuation of external costs is a difficult process. It is often prohibitively expensive or sometimes impossible to trace the pathways of pollutants through an ecosystem and assess all the resulting damages in the present, let alone potential future damages. Similarly, it is difficult to assign a value for human disease or premature death. Even if a thorough damage or risk assessment is completed, assigning an appropriate monetary value for these external costs can be controversial.

For example, it is difficult to establish the price at which all individuals whose health is impacted by emissions would be willing to tolerate those emissions. Economists frequently advocate the use of carefully constructed public opinion surveys to assign monetary values to externalities. Ideally, this tells us what a representative sample of the population believes the externalities to be worth. In practice most people have no experience in assigning prices to environmental impacts. For instance, public opinion surveys regarding the value of reduced visibility at the Grand Canyon due to air pollution arrived at very different answers.

Another difficulty is that surveys have not been done for most environmental problems, creating a temptation to use inappropriate approximations and shortcuts. Even when valuation estimates are available, there are often analytical and philosophical questions about their interpretation. Since many environmental problems involve some increased risk of death, internalization of external costs appears to require a dollar value for a human life. The value of a human life is often estimated to be worth about $6 million in 1999 dollars. This is based on economic analyses of the wages required to induce blue-collar men to enter risky occupations in the 1970s and 1980s,[3] adjusted for inflation since the original studies but otherwise unchanged. Use of the $6 million value is becoming standard in environmental economics. However, it begs both the practical question of whether job choices made by a subset of the population in the past should be a universal standard today, and the philosophical question of whether it is acceptable to assign a dollar value to a human life.

Even the sulfur limit for the Clean Air Act's tradable permit market was not based solely on science, but was a negotiated settlement, heavily influenced by estimates of the cost of the technology for sulfur reduction. Moreover, there are limits, in terms of administrative cost and complexity, to the number of separate emissions trading systems that can be established and operated simultaneously. In practice, trading systems are likely to apply only to the best-known or most problematic pollutants.

Despite these limitations and pitfalls, valuation of external costs can be a powerful tool. The tradable permit system did internalize some of the previously external costs and reduced the emissions of sulfur dioxide to roughly half the 1980's emission peak. This example shows that it is possible to internalize external costs and get results using our economic system.

Relationship between Sustainability and Solid Waste Policy

When managers include external environmental costs in decision making they move toward environmental sustainability. But what is sustainability and how can progress toward sustainability be evaluated? The Natural Step is a common framework to explain the principles of environmental sustainability.[4] It delineates a set of guiding tenets, called "system conditions." The four system conditions for society to be sustainable can be paraphrased as follows with commentary and implications for solid waste management in italics:

1) **Limiting or eliminating certain substances from being extracted from the earth's crust, or closed-loop use of those substances, to prevent adverse effects on living organisms and ecosystems**.
The rate of materials extraction from the earth's crust must not systematically exceed the rate at which those materials are sequestered back into the earth's crust. This condition addresses problems such as global warming due to extraction and use of hydrocarbons, toxic metals, and mineral substances released into air, land and water. It is easy to see solid waste connections to this system condition. Materials that are extracted from the earth to make products which are subsequently disposed of can violate this system condition.

2) **Limiting or eliminating certain persistent substances created by humans**.
Because these human-made substances are not part of the natural system, humans and other species are incapable of metabolizing these chemicals and they tend to disrupt biologic systems. Therefore, these substances should not systematically increase in the environment. This condition addresses problems such as persistent bioaccumulative toxic chemicals and endocrine disrupters that have become widespread in the environment. Some persistent chemicals are a part of the MSW stream.

3) **Avoid destructive manipulation of the natural ecosystems**.
This condition addresses problems such as declining biodiversity, overharvesting, natural systems carrying capacity, and habitat preservation. Pollutants generated from the management and disposal of solid waste can add to this problem.

4) **Use resources efficiently, minimize wastes, to equitably support human needs**.[5]
This condition is a guiding principle that addresses the general need for humans to be conservative in the use of resources to retain a planet that can support our species in the long-term. This also has direct policy implications for population growth and the global

distribution of natural resources for the global human community. This speaks directly to the pollution prevention and waste reduction aspects of solid waste management.

Support for sustainability is evidenced in Department of Ecology's mission statement and goals. The mission of the Department of Ecology is to "protect, preserve and enhance Washington's environment, and promote the wise management of our air, land and water for the benefit of current and future generations."[6]

To fulfill this mission Ecology has established three goals:

- Prevent pollution
- Clean up pollution
- Support sustainable communities and natural resources

To meet these goals the solid waste system must incorporate sustainable practices. To have a sustainable system there must be a sustainable economy and a sustainable environment. A sustainable solid waste system might include closed-loop recycling back into the economic (sustainable economy), and natural (sustainable environment) systems while sharing the benefits and burdens of solid waste management equitably among all our citizens.

Producer, consumer and waste management decisions such as transportation, materials, and product choices impact efficient resource use and waste minimization potential. For instance, in many cases producers have a choice of manufacturing products with virgin materials or with recycled materials. Consumers can choose to purchase materials or products that are made from virgin materials or reused/recycle components. Both producers and consumers can often make choices between products with more or less toxic ingredients or components. Many solid waste managers in Washington are already providing programs that contribute to sustainability by encouraging reuse and recycling as well as educating consumers about purchasing less toxic products and services. Some solid waste programs are actively engaging product manufacturers in creating more sustainable products and services as well as modifying purchasing policies to reflect more environmentally benign purchases.

Nature fulfills the sustainability system conditions in The Natural Step by using outputs (potential wastes) from one part of an ecosystem as an input (feedstock) to another part of an ecosystem, creating little or no waste. Some use this fact to advocate for a "zero waste" goal or strategy for human production systems and for solid waste management. The concept of zero waste may seem on the surface to be idealistic. However, a zero waste goal has been applied by leading industries in the US and elsewhere for some time.

For example, in the 1980s E.I. DuPont de Nemours & Company (DuPont) expanded the corporate mission from zero injuries to "zero waste, zero emissions, and zero injuries." This changed mission has resulted in reducing toxic emissions by 74%, cutting solid waste generation in half and reducing its overall environmental costs by $200 million per year.[7] At DuPont, zero waste is not an absolute but rather a way for management and workers to think and to drive competitive innovation. DuPont's CEO says that "We are on a journey to transform DuPont into a sustainable growth company, one where we increase societal value while decreasing our environmental footprint."[8] DuPont is perhaps not yet a fully sustainable company but they are consciously and deliberately moving in that direction. A zero waste goal may not be achievable in all cases; however, any other goal may artificially limit the maximum achievable reduction in waste.

It is unclear how to measure or assess how far we are from sustainability in the management of solid waste. Solid waste is typically managed by using traditional cost-benefit analysis, whether in the private or public sector. These traditional cost-benefit analyses are assumed to provide solid waste managers and political decision-makers with data to make informed decisions. There is a need for alternate methods that include those factors that support sustainable solid waste practices and that are ignored with the traditional cost-benefit analysis. There is an increasing body of research, policy exploration, and new analytical methods that have been designed to start to fill this need.[9] One such method is life-cycle assessment.

Life-Cycle Assessment (LCA)

Industries and governmental organizations have developed methods that extend the scope of the traditional cost-benefit analysis system toward sustainability. One of the most widely used of these methods is called Life-Cycle Assessment (LCA). LCA includes two parts, the life-cycle inventory (LCI) and the life-cycle impact assessment (LCIA). The LCI is typically the first phase of a Life Cycle Assessment, and involves compiling and quantifying the material and energy inputs and outputs for a given product throughout its life cycle. LCI data now exists for a significant number of products and many of their associated inputs and outputs of energy and materials such as emissions of environmental pollutants.

The second, and more difficult, phase of an LCA is the LCIA. This is the phase of a life-cycle assessment that evaluates impacts caused by emissions of environmental pollutants documented during the LCI phase of the assessment. Examples of potential impacts evaluated by LCIA include financial, environmental, social, and public health burdens rendered from the pollutant emissions. Once the system-wide impacts are quantitatively estimated, an estimate of the cost of each impact can sometimes be developed.

The LCA can be used to expand the scope of traditional cost-benefit analysis of solid waste alternatives. The traditional cost-benefit analysis methods only examine the functions of the solid waste system under the influence of solid waste managers. For example, a recycling facility may receive, sort, and otherwise process waste to become a marketable commodity. Once the commodities are sent to the market the impacts of those materials are no longer accounted for in the solid waste system. By expanding the scope of cost-benefit analysis we can evaluate the positive and negative impacts of our resource use and materials management options.

Figure 1 illustrates that there are **upstream** and **downstream impacts** not usually included in managing the traditional solid waste system. Upstream impacts are positive as well as negative consequences of product manufacturing or use before the product has become a waste. This includes energy use, materials use (virgin or recycled sources), and pollutant emissions associated with product transportation, manufacture, and consumption. Downstream impacts are positive and negative consequences after discarded products have been managed by the solid waste system. This includes potential pollutant emissions and energy recovery from landfills and waste-to-energy facilities.

LCA includes impacts upstream and downstream of the solid waste management system. For example, upstream impact comparisons can include the use of recycled versus virgin materials in manufacturing products. Downstream impacts may include estimates of the amount of greenhouse gases released from choosing different disposal methods.

Although LCA expands the traditional cost-benefit analysis, the costs or benefits of some impacts can be estimated with more precision and accuracy than others. For example, if health effects are present they may not be easily quantified. In addition, different sectors of society (e.g., businesses, and urban or rural communities) may be impacted more or less. A community closer to recycling markets may benefit more from recycling programs.

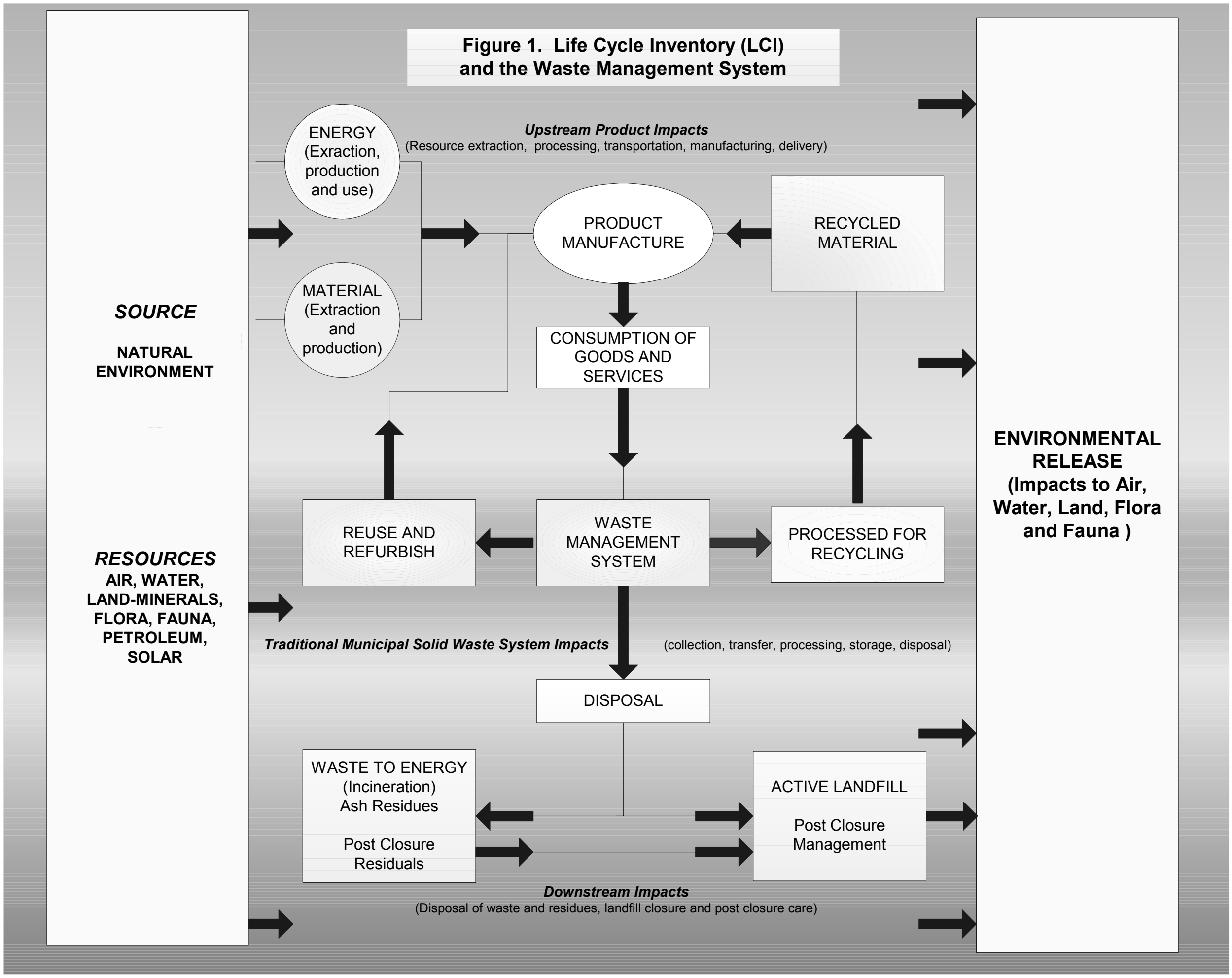
The data for a comprehensive LCA is not yet available for some parts of the MSW stream. For instance, there is not enough data available regarding upstream impacts of recycling organic materials. However, there is a significant body of knowledge available to begin evaluating the specific impacts of solid waste management choices using LCA, such as recycling versus disposal of certain commodities. Nonetheless, there is a need to further develop new methods, tools and measures to evaluate sustainability in the context of solid waste management.

Section 1 Summary

This section suggests that when external costs are not fully reflected in the market price for a product, the resources used for the product can be undervalued and may not be used efficiently or sustainably. The section shows that it is possible to internalize external costs once they are identified and get results using our economic system in correcting the prices of goods. When we expand the scope of cost-benefit analyses, we can evaluate the positive and negative impacts of our resource use and materials management options.

Full-cost accounting can help align the costs within the solid waste system, although if it fails to consider future costs, the full-cost accounting method would be incomplete. Full-cost accounting does provide a more sound basis than historic accounting methods used for decision-making in the solid waste system. The solid waste system still needs alternate methods to include those factors supporting sustainable solid waste practices and that can be missed with the traditional cost-benefit analysis.

Appendix A provides an example of an abbreviated life cycle inventory (LCI) of the Washington State single-family residential recycling system. Section 2 of this paper provides examples of available studies that can assist solid waste managers in developing LCIs.



Products vary widely, from firewood and water, which are minimally processed, to automobiles and skyscrapers, which are resource and energy intensive. Product life cycle begins when materials (gases, water, minerals, plants, animals, fish, etc.) are extracted from the environment as a resource for conversion to a useful product. This is followed by processing, manufacturing, distribution, retailing, consuming and disposal. Each step along the way requires the need for additional materials and energy to pass materials and products to the next step. Each step along the way generates pollution and waste that are released into the environment. Each step along the way has economic, environmental and social costs or impacts.

Solid waste management has traditionally focused on wastes generated after product consumption. However, there are impacts before product consumption (upstream impacts) and impacts after disposal (downstream impacts), that are most times not considered in the total cost of the products. These costs are often borne by the general public and are not associated with the product itself. For example, the U.S.D.A Forest Service builds roads into forests at taxpayer expense to provide access to timbers stands that are logged. The trees are harvested by the highest bidder, and sold by that bidder for profit after value has been added (e.g. cut into lumber). The cost of the road is not included in the price of the timber since the Forest Service does not recover this cost from the bidder. This is a government subsidy. All tax payers contribute to the costs of the road regardless of whether or not they buy the lumber.

Section 2:
Moving From Economic Theory to Practice

Because they are indirect and will often go unnoticed, it is not easy to quantify external costs. In section 1, an example of external costs was highlighted that included the habitat loss and environmental pollution associated with mining. A first step in quantifying these elusive costs is to identify what needs to be measured and then assign costs to the impacts, both positive and negative. Some environmental and energy projects and studies have attempted to quantify the cost of specific environmental impacts. The studies described below may be useful in evaluating Washington's solid waste system, or provide input to a life-cycle assessment (LCA) or a life-cycle inventory (LCI).

Life Cycle Inventory Studies

A complete LCI study of the solid waste system should include, to the extent possible, LCI data for all impacts, including those upstream and downstream of the system. Industry and governmental agencies have been tracking emissions of certain pollutants to the air and water for a number of years. In the past decade, researchers have used this data along with other information to conduct life-cycle inventory (LCI) studies on waste management systems. Most LCI studies attempt to examine the average life-cycle of a product, from raw materials acquisition through management of residuals at the end of the product's life, to determine material and energy inputs, waste outputs, and environmental releases associated with the use of that product.

LCI data can be used to compare recycled-content manufacturing to virgin-content manufacturing. The upstream LCI data for recycled-content manufacturing are combined with LCI data for collection, processing and transportation impacts of the recycling system. The upstream LCI data for virgin-content manufacturing are combined with LCI data for collection, transfer, hauling and disposal impacts of the traditional disposal system. Additionally, upstream LCI data for specific waste prevention or reduction methods can be compared to LCI data for recycling and disposal.

A life-cycle inventory study quantifies the inputs and outputs associated with a product without placing a dollar value on the impacts. Once the LCI is completed, dollar values may be assigned to the impacts as part of the LCA. The three general categories of impacts often used in LCI studies of the solid waste system are: pollutant emissions, natural resource use, and energy use. Some studies have included all three of these categories while some go further by assigning costs to these impacts (Table 1).

Five Life-Cycle Inventory Studies

The five LCI studies in Table 1 include data for the solid waste system; however, LCI data for the system are limited. Additionally, a study of the impacts of the solid waste system needs to recognize that there are often market differences between virgin materials and recycled-content materials. The five LCI studies (Table 1) differ substantially in their coverage of specific solid waste management methods and types of residuals. There are also differences in availability of data measuring discharges throughout a product's complete life cycle for each particular pollutant; Table 2 explains the emissions included in each of the 5 LCI studies.

EPA's decision support tool (DST) study examines 39 residuals, 17 of which include both upstream and end-of-life LCI data (Table 3). The EPA DST study also develops energy profiles for various solid waste management methods; use of natural resources is covered indirectly through energy use calculations. The EPA study was conservative in its scope. For instance the organic waste stream components such as grass, leaves, branches and food waste lack upstream LCI data. The effect of reduced emissions from reduced use of synthetic agricultural products, nor the effect of compost as an alternative agricultural product, has yet been evaluated. Specific processes for preventing or reducing waste, e.g. double-sided copying or glass container reuse, have not been evaluated by the EPA. [10]

The **Australian recycling** study assigns a dollar value to certain pollutant emissions and analyzes the land use and resource conservation impacts associated with various waste management methods. This study examines a variety of curbside collection and processing systems for mixed paper, newspaper, glass containers, aluminum cans, steel cans, PET bottles, HDPE bottles and paperboard drink cartons.[11]

The study conducted for the **Minnesota Office of Environmental Assistance** (MN OEA) examines the impacts of waste reduction for five materials: office paper, wooden pallets and containers, corrugated cardboard, glass containers, and plastic containers. The Minnesota study also evaluates the impacts of recycling newspaper, corrugated cardboard, glass containers, aluminum cans, steel cans, PET bottles and HDPE bottles. This study includes a partial examination of the life-cycle impacts of composting, and of recycling used oil and scrap tires. Additionally, this study includes natural resource conservation in terms of coal, natural gas, crude oil, iron ore and limestone in its comparison of waste management methods. [12]

The **Keep American Beautiful (KAB)** study develops energy profiles for various solid waste management methods; the impacts of natural resource use are covered indirectly through energy use calculations. The KAB study also examines the management impacts of residential yard debris that are composted, incinerated or put in a landfill. The KAB study focuses on management methods, such as recycling, incineration and landfilling, of residential residuals of newspapers, glass containers, aluminum cans, steel cans, PET bottles and HDPE bottles and containers. [13]

The **Council of State Governments (CSG)** study conducted by the Tellus Institute focuses on developing an LCI for material and energy use along with air and water emissions associated with disposal of a list of specific packaging materials: aluminum, glass, steel, five types of paper, and six types of plastic. The CSG study also assigns dollar values to certain pollutant emissions. [14]

<u>Using Emission Data as a tool for LCA</u>

Once emission data are available for different methods of solid waste management, pollutant loadings from each alternative may be compared. Some options may increase certain emissions while reducing others. One method for evaluating these trade-offs is to convert pollutant loadings to dollar costs. Assigning dollar costs to each type of emission shown in Table 4 is typically performed by estimating costs of damages caused by emissions or by estimating costs incurred to control releases of the pollutant.

Examination of Table 4 reveals the diversity of estimates available for assigning an environmental cost to pollutant releases. Because all values are in dollars, trade-offs between types of pollution can be evaluated. For example, atmospheric emissions of chlorinated/aromatic hydrocarbons are given a higher dollar value than waterborne emissions for chlorinated/aromatic hydrocarbons. The opposite is the case with mercury. On the other hand, on a pound for pound basis, both of these pollutants are much more damaging than atmospheric emissions of sulfur, nitrogen oxides, or of particulates based on the dollar values assigned. However, to choose among waste management methods, the researcher needs to calculate the quantity of each pollutant's releases times the value of that release. This is typically done using the releases associated with managing a ton of each waste stream residual under each management method.

Several methods or techniques are available to develop each type of cost estimate, each with particular strengths and weaknesses. However, there are substantial technical difficulties involved in getting complete and accurate estimates of externalized costs using any of these standard methods for estimating damage or control costs. This has led to protracted debate among proponents of one or another method for estimating externalized costs, and to wide variations in the actual estimates as well. The various approaches to assigning values to externalities involve a high degree of uncertainty, resulting in a wide range of possible economic valuations. Some experts have suggested that, lacking an agreed-upon methodology, the values assigned to externalized costs should be, in effect, negotiated through the public political process. [15]

<u>Limitations of Emissions Estimates</u>

Although the dollar valuation of emissions helps in comparing different pollutants, the underlying studies have certain limitations that must be acknowledged. None of the studies report upstream and downstream emissions for all pollutants listed in Table 2. Additionally, none of these studies have emission data for all waste residuals. For example, the EPA study provides a comprehensive comparison of emissions from recycling versus disposal options for just 17 of the residuals in Table 3. Those 17 residuals are noted with the word “yes” in column 2 of Table 3.

Where there was a gap in the data on emissions of a particular pollutant for a particular recycling or disposal method in the EPA study, they decided not to report data on emissions from any waste management method for that pollutant. This was done to avoid implications of bias in the study. For example, waterborne dioxin/furan emissions data were not available for all MSW management methods. As a result, the EPA DST study does not report dioxin/furan emissions for any waste management method, even though those emissions are available in other studies for specific management methods such as disposal through waste-to-energy incineration.

The absence of emissions data in the EPA study should not be interpreted as an indication that these residuals are associated with zero emissions of these pollutants. The other four studies referenced in Table 2 provide emissions data from the life-cycle of some residual type for each of these other pollutants. Additionally, it was not possible within the scope of this review to determine whether the non-EPA studies had any data gaps such as missing downstream data, as shown by the "up only" entries in Table 2. Coverage of pollutant emissions in the Australian study, as well as the other three studies, is indicated by an "x" in each study's column of Table 2.

These limitations point out the complexity of life-cycle analysis and the significant amount of work that remains to be done to develop a complete LCI for all residuals. Although limitations exist, the data available is usable and the ongoing research being performed in the US and elsewhere will provide additional data for analysis.

Use of Natural Resources

Another type of impact that can be measured in an LCA is natural resources use and depletion. Studies on the economic and environmental costs and benefits of solid waste management systems sometimes include an analysis of land use and resource conservation impacts associated with various waste management methods. For example, the Australian Packaging Covenant Council's study of curbside recycling concluded that 75% of the overall environmental benefit of curbside recycling came from reductions in air and water pollutant emissions associated with reduced use of virgin raw materials to manufacture products.[16] That study also concluded that land use benefits from reduced mining and harvesting of mineral and forestry resources accounted for 21% of the benefits from recycling. Global warming credits accounted for 4%, while benefits of reduced land use for landfills accounted for another 2%. These environmental benefits of recycling were offset by environmental costs from increased truck traffic. Environmental costs from truck traffic offset 2% of total benefits.

The estimate that 21% of environmental benefits from recycling came from reduced use of mineral and forestry resources excluded the benefits associated with reduced emissions of pollutants and greenhouse gases to avoid double counting the benefits of emissions reduction. Included in this 21% of total environmental benefits were impacts related to land use and sustainability of resource access for bauxite, coal, crude oil, iron ore, lignite, limestone, natural gas and sand.[17]

The Australian study combined estimated costs for rehabilitating land used for coal mining and estimated resource depletion costs for coal to obtain an estimate of US $26 per ton as the land use and resource depletion cost for coal. It is worth noting here that establishing a resource depletion value for coal or any other natural resource is not simple. In the case of coal it involves in some inevitable degree a prediction about tastes and needs of future generations, future coal stocks, and future technology. Even estimating the stock of coal in the earth today is a tricky business, involving as it does geologic data on locations of known and likely coal stocks, and technological data on how deep one can dig for coal and how free the vein of coal has to be from other minerals and rock for it to be recoverable. Thus, the figure chosen to measure the extra value (its resource depletion value) coal would have, were future generations able to bid in today's markets, must sum up predictions and estimates about today's stocks, future stocks versus the rate of depletion of today's stocks, future technological capabilities to recover stocks inaccessible with today's technology, and future needs for coal resources.[18]

Similar difficulties would be encountered in estimating the land use and resource depletion value from reduced use of other natural resources as well. Instead, the Australian study used an international scale based on biodiversity and primary biomass productivity impacts to rank coal against the other mineral resources in terms of land use. The study also compared global production with global resource stocks for each mineral versus coal's estimated 700 years of remaining resource life. Combining these land use and resource depletion rankings for the other mineral resources against coal with coal's estimated $26 per ton externalized cost, the Packaging Covenant Council's study derived environmental valuations that ranged from a low of under $6 per ton for sand to a high of almost $61 for bauxite. Interestingly, limestone and iron ore fell toward the top of this range - at $50 and $44 per ton, respectively - while natural gas and crude oil were just above sand at the bottom with valuations of about $20.[19] This result is most likely related in part to the smaller impact on land surface ecosystems associated with oil and natural gas drilling compared with surface and strip mining for iron ore and limestone.

The Australian study used "hypothetical non-wood charges" for forest resources to develop a land and natural resource use environmental cost for trees from native, regrowth and plantation forests. The estimates reported in the study are $20 per ton for timber cut from native forests, $7 for regrowth, and $3.50 per ton for plantation timber.[20]

Minnesota OEA's evaluation also included natural resource conservation of coal, natural gas, crude oil, iron ore and limestone in its comparison of waste management methods but did not attempt to calculate a monetary value for natural resources conserved. The EPA DST model, the Keep America Beautiful study, and the Council of State Governments study cover natural resource conservation only indirectly through calculations of energy use for solid waste management methods.

Energy Use

Numerous studies have examined the energy conservation and consumption impacts of solid waste management. Three of the five studies inventoried in Table 1; EPA's Decision Support Tool, Keep America Beautiful, and the Council of State Governments studies; developed energy profiles for the various management methods. Richard Denison of the Environmental Defense Fund published a review of the Keep America Beautiful and Council of State Government studies, as well as a review of two other studies, A US Department of Energy study by Stanford Research Institute and a Toronto Pollution Probe study, by Sound Resource Management Group.[21]

Denison's summary of the energy impacts of recycling, incineration and landfill reflects the conclusions of the four studies as well as others that have been conducted on energy usage in solid waste. According to Denison,

> From a system-wide view, recycled production plus recycling uses the least energy, considerably less than virgin production plus incineration, whereas virgin production plus landfilling uses the most. This difference is due to the substantial reduction in energy use associated with manufacturing processes that use recycled materials relative to those that use virgin materials.[22]

Denison also states that transportation energy used to ship processed recycled materials to market is minimal, amounting to only a few percent of manufacturing energy.[23]"

Because many of the emissions of pollutants associated with waste management methods arise from energy use specific to those methods, energy consumption can be used to estimate relative environmental impacts of different solid waste management methods. It is relatively easy to measure energy use based on market purchases of energy resources throughout a product's life cycle. It is often more difficult to measure or estimate emissions of numerous pollutants. At the same time, it is important to remember that environmental benefits from reduced use of energy are reflected in emission reductions and reduced use of mineral resources.

Some energy resources are under-priced due to subsidies or external costs in energy markets. For example, the impacts on salmon from hydroelectric power generation have not historically been included in prices paid by the consumers of hydropower. Similarly, most, if not all, of the costs for long-term management of radioactive wastes and for security needs related to nuclear energy are not included in prices paid by consumers of electricity. A study on the sustainability of solid waste systems should include the costs that would result if energy prices were not subsidized and external costs were internalized into the market price of energy. Presumably the higher energy usage methods would find their costs rising relative to less energy intensive waste management methods.

Section 2 Summary

This section shows that there are tools available to help identify some of the external costs of managing certain products throughout their lives. Some of these external costs include manufacturing and transportation emissions, natural resource degradation, and energy consumption subsidies. Quantifying the impacts of pollutant emissions, natural resource use and energy consumption can be useful in the solid waste system.

This section found that overall emissions from upstream virgin raw materials acquisition and production activities are much larger than emissions from MSW management methods. There are also substantial technical difficulties involved in getting complete and accurate estimates of external costs. One tool, a life cycle inventory (LCI), provides data that can be used to compare recycled-content manufacturing to virgin-content manufacturing. There is, however, significant complexity in life-cycle analysis, and a significant amount of work remains to be done to develop a complete LCI for all residuals. Although there are limitations, the data available is usable and the ongoing research being performed in the US and elsewhere will provide additional data for analysis.

There is also a substantial overall reduction in energy use associated with manufacturing processes that use recycled materials relative to those that use virgin materials. A study on the sustainability of solid waste systems should be undertaken that includes the costs that would result if energy prices were not subsidized and external costs were internalized into the market price of energy.

The studies looked at in this section have strengths and weaknesses that should be recognized. Even though there is somewhat limited data available to evaluate certain parts of the solid waste management system, the studies shown here demonstrate that LCI information is available. Solid waste managers can consider use of these efforts to evaluate their management choices. Appendix A provides an example of using a limited set of Washington State data to estimate some LCI-based costs of residential curbside recycling in four demographic areas.

Table 1. Data Evaluated in Studies

Data Source	LCI Study	Emissions	Dollar Value on Emissions	Natural Resource Use	Energy
US EPA DST[24]	X	X		X	X
AUS Recycling[25]	X	X	X	X	
MN MSW[26]	X	X		X	
KAB Recycling[27]	X	X		X	X
CSG Packaging[28]	X	X	X	X	X
MN Utilities Com.[29]		X	X		
Office of Tech. Assessment[30]		X	X		
Market Trades[31]		X	X		

Data gaps such as missing downstream data are shown by the "up only" entries in Table 2. Coverage of pollutant emissions in the Australian study, as well as the other three studies, is indicated by an "x" in each study's column of Table 2.

Table 2. Waste System Study Atmospheric & Waterborne LCI Emissions Data

Emissions Included in LCI Study	EPA* MSW 2001	AUS RCY 2001	MN MSW 2000	KAB RCY 1994	CSG PKG 1992
EPA Criteria Air Pollutants					
1. Ozone (O_3)					
2. Carbon Monoxide (CO)	both	x	x	x	x
3. Nitrogen Oxides (NO_x)	both	x	x	x	x
4. Sulfur Oxides (SOx)	both	x	x	x	x
5. Particulates less than or equal to 10 micrometers (PM_{10})					x
6. Particulates less than or equal to 25 micrometers (PM_{25})					
Particulates (Total)	both	x	x	x	x
7. Lead (Pb)	both	x			x
Greenhouse Gases Targeted by the Kyoto Protocol					
1. Carbon Dioxide (CO_2)	both	x	x	x	
2. Methane (CH_4)	both	x	x	x	x
3. Nitrous Oxide (N_2O)	both	x			
4. Hydrofluorocarbons (HFCs)					
5. Perfluorocarbons (PFCs)					
6. Sulphur Hexafluoride (SF_6)					
Additional Greenhouse Gases					
7. Chlorofluorocarbons (CFCs)					
8. Ozone (O_3)					
9. Water Vapor (H_2O)					
Other Atmospheric Emissions					
1. Hydrocarbons (non CH_4)	both	x	x	x	x
2. Ammonia (NH_3)	both	x		x	x
3. Hydrochloric Acid (HCL)	both	x		x	x
4. Mercury (Hg)		x			x
5. Aldehydes (including Formaldehyde)	up only			x	x
6. Hydrogen Fluoride (HF)	up only	x		x	x
7. Chlorine	up only			x	x
8. Kerosene	up only				
9. Antimony	up only				
10. Arsenic (As)	up only	x			
11. Beryllium	up only				
12. Cadmium (Cd)	up only	x			
13. Chromium (Cr)	up only	x			
14. Cobalt	up only				
15. Manganese	up only				
16. Nickel (NI)	up only	x			
17. Selenium	up only				
18. Acreolin	up only				
19. Benzene	up only	x			x
20. Perchlorethylene	up only				
21. Trichlorethylene	up only				
22. Methylene Chloride	up only				
23. Carbon Tetrachloride	up only				x
24. Phenols	up only				x
25. Naphthalene	up only				x
26. n-Nitrosodimethlate	up only				
27. Radionuclides	up only				
28. Dioxins/Furans		x			
29. Copper (Cu)		x			
30. Zinc (Zn)		x			
31. Hydrogen Sulfide (H_2 S)		x			x
32. Chlorinated/Aromatic Hydrocarbons		x			x
33. Metals			x	x	
34. Other organics				x	

Table 2 (cont.)
Waste System Study Atmospheric & Waterborne LCI Emissions Data

Emissions Included in LCI Study	EPA* MSW 2001	AUS RCY 2001	MN MSW 2000	KAB RCY 1994	CSG PKG 1992
Waterborne Releases					
1. Dissolved Solids	both			x	
2. Suspended Solids	both	x	x	x	x
3. BOD	both	x	x	x	x
4. COD	both	x	x	x	x
5. Oil	both			x	x
6. Sulfuric Acid	both			x	
7. Iron	both	x		x	
8. Ammonia	both	x	x	x	x
9. Copper	both	x			x
10. Cadmium	both	x			x
11. Arsenic	both	x			x
12. Mercury	both	x			x
13. Phosphate	both				
14. Selenium	both				x
15. Chromium	both	x			x
16. Lead	both	x			x
17. Zinc	both	x			x
18. Acid	up only			x	
19. Metal Ion	up only			x	
20. Phenol	up only	x		x	x
21. Sulfides	up only	x			x
22. Cyanide	up only			x	x
23. Nickel	up only	x			x
24. Chloride	up only	x			x
25. Sodium	up only				
26. Calcium	up only				
27. Sulfates	up only				
28. Manganese	up only				
29. Fluorides	up only	x		x	x
30. Nitrates	up only	x	x		
31. Phosphates	up only		x		
32. Boron	up only				
33. Chromates	up only				
34. Chlorinated/Aromatic Hydrocarbons		x			x
35. Dioxins/Furans		x			x
36. AOX (adsorbable organic halides)		x			
37. Total Organic Compounds		x			x
38. Hydrocarbons			x		x
WA Dept. of Ecology Persistent Bioaccumulative Toxics					
1. Aldrin/Dieldrin					x
2. Chlordane					
3. DDT (DDD & DDE)					x
4. Toxaphene					
5. Benzo(a)pyrene		x			x
6. Dioxins and Furans	up only	x			x
7. Hexachlorobenzene		x			
8. Mercury		x			x
9. PCBs		x			

*In the EPA MSW column "both" means that the EPA study provides upstream emissions data for virgin raw materials acquisition and refining plus virgin- vs. recycled-content product manufacturing, as well as downstream emissions for solid waste methods. An "up only" means that the study provides emissions data for only the upstream part (raw materials acquisition plus product manufacturing) of a waste component's life cycle.

Table 3
LCI Data Availability in EPA's DST Model

Residential Waste Component	Upstream LCI Data	Solid Waste Methods LCI Data
Yard Waste		
1. grass	no	yes
2. leaves	no	yes
3. branches	no	yes
4. food waste	no	yes
Ferrous Metal		
5. cans	yes	yes
6. other ferrous metal	yes	yes
7. non-recyclables	no	yes
Aluminum		
8. cans	yes	yes
9 - 10. other aluminum	no	yes
11. non-recyclables	no	yes
Glass		
12. clear	yes	yes
13. brown	yes	yes
14. green	yes	yes
15. non-recyclable, non-container glass	no	yes
Plastic		
16. translucent HDPE	yes	yes
17. pigmented HDPE bottles	yes	yes
18. PET beverage bottles	yes	yes
19. LDPE film/bags	yes	
20 - 24. other plastic	no	yes
25. non-recyclable plastic	no	yes
Paper		
26. newspaper	yes	yes
27. office paper	yes	yes
28. corrugated containers	yes	yes
29. phone books	yes	yes
30. books	yes	yes
31. magazines	yes	yes
32. third class mail	yes	yes
33 - 37. other paper	no	yes
38. non-recyclable paper	no	yes
39. miscellaneous	no	yes

Table 4 Economic Valuation of Atmospheric and Waterborne Emissions ($ / lb)

Atmospheric & Waterborne Emissions	AUS RCY 2001	CSG PKG 1992/94	MN PUC 1995	OTA REVIEW 1994	MKT TRADES 2000/01
Atmospheric Emissions					
Carbon Monoxide (CO)	$0.007	$0.48		$0.43 - 0.45	
- urban			$0.0008		
- suburban			0.0005		
- rural			0.0002		
Nitrogen Oxides (NO_x)	1.04	4.53		0.82 - 3.70	0.41
- urban			0.34		
- suburban			0.11		
- rural			0.03		
Sulfur Oxides (SO_x)	0.12	2.23		0.75 - 0.79	
Sulfur Dioxide (SO_2)				0.88 - 2.13	0.07
- urban			0.08		
- suburban			0.04		
- rural			0.01		
Particulates (Total)	2.56	1.30		1.19 - 1.25	
Particulates (PM) 10 - urban			2.72		
- suburban			1.22		
- rural			0.35		
Lead (Pb)	0.19	528.00			
- urban			1.75		
- suburban			0.91		
- rural			0.21		
Carbon Dioxide (CO_2)	0			.0068 - .012	0.0002
- urban			0.0009		
- suburban			0.0009		
- rural			0.0009		
Methane (CH_4)	0.26	0.01		0.11 - 0.38	
Nitrous Oxide (N_2O)	0			1.98 - 2.08	
Hydrocarbons (non CH_4)	0.26				
Ammonia (NH_3)	12.47	0.76			
Hydrochloric Acid (HCL)	2.49				
Mercury (Hg)	3,915.90	2,464.00			
Hydrogen Fluoride (HF)	2.49				
Arsenic (As)	2,317.88	7,477.29			
Cadmium (Cd)	966.62	1.606.34			
Chromium - trivalent	0.24	0.74			
- hexavalent	22,831.08				
Nickel (Ni)	231.77	137.89			
Dioxins/Furans	153,177.31				
- 2378-TCDD		42,646,153.85			
Copper (Cu)	28.55	19.90			
Hydrogen Sulfide (H_2S)	11.99	11.46			
Chlorinated/Aromatic Hydrocarbons	1,598.48				
Waterborne Releases					
Suspended Solids	$6.23				
BOD	0.08				
COD	0				
Iron	0				
Ammonia	1.84	0.76			
Copper	9.59	19.90			
Cadmium	215.78	1,606.34			
Arsenic	11.99	7,477.29			
Mercury	6,233.72	2,464.00			
Chromium	335.66				
Lead	61.54	528.00			
Zinc	0.56	3.70			
Phenols	87.91	1.23			
Nickel	0.04	137.89			
Chloride	199.81				
Sulfates	0.12				
Fluorides	199.81	12.32			
Nitrates	0.12				
Chlorinated/Aromatic Hydrocarbons	303.69				
Dioxins/Furans	74,325.11				
- 2378-TCDD		42,646,153.85			
AOX (adsorbable organic halides)	0.005				
Total Organic Compounds	0				

Section 3:
Barriers to Recycling

Introduction

Current waste management practices have been developed around the concept of "waste" as a post-industrial and post-consumer discard; the requirement to deal with the waste after it is generated has been the standard protocol In the early 1990's, as communities faced the challenge of closing facilities that were inexpensive to operate but which did not meet new landfilling standards, the need to reduce disposal seemed very obvious. The public was aware of a "landfill crisis." Disposal prices in many places jumped as jurisdictions began to pay for waste transport, and for better environmental protection. Various communities fought battles over landfill expansions and proposed waste-to-energy incinerators. Newly instituted curbside programs were fresh in the public consciousness, and people saw a direct connection between the new bins and the overall problem. However, solving the "crisis" eventually exacted a price. Waste export systems removed the pressure to conserve landfill space, and rapidly expanding curbside programs increased volumes of recyclable materials, driving down commodity prices. At the same time, the remarkable economic growth of the 1990's encouraged companies to focus on increased volume rather than looking for cost savings that waste reduction and recycling could generate on the margin. As people got used to the new, higher cost of solid waste disposal, the disposal price was no longer an incentive to recycle. For most businesses, disposal costs were not a large enough part of their budget to be worried about increased waste reduction and recycling while the economy was so hot. The combination of low priority and poor market proces (which raised the cost of commercial recycling) stymied commercial recycling efforts.[32]

A 50% statewide recycling goal has been established for Washington. Recycling can be a key solid waste management method to conserve resources in keeping with the principles of sustainability. Barriers to recycling reduce the recycling rate and act to increase the cost of recycling versus disposal. To move toward sustainability we need to look at the barriers to recycling.

This issue paper identifies a number of barriers to recycling. The solid waste plan will support a transition from current waste management practices to an alternative sustainable resource management system as a component of economic development. This includes a sustainable economic system that is based on resource and energy conservation, pollution prevention, waste reduction and material reuse. This section of the issue paper is concerned with materials recycling and, specifically, identification of barriers to the improvement and expansion of materials recycling programs.

Current Recycling Practices

Current recycling practices began with a focus on the materials that came from residential and business consumption and from commercial manufacturing processes particularly in the paper industries. In recent years, with increased interest in composting and the introduction of bans on outdoor burning, yard waste has become the commodity forming the highest proportion of the recycled waste stream, rising from 19% of the total tons recycled in 1996 to 30% in 1998[33]. [34] Other highly recycled materials in 1998 included corrugated paper, newspaper, mixed waste paper, and ferrous metals.Interest in expanding the scope of recycling programs has focused recently on construction materials, computers and other electronics, agricultural waste, and other organics.

While environmental reasons are often advocated in support of recycling, today's recycling industry is based largely on traditional economic concepts: the diversion of certain commodities from the waste stream for re-sale and profit and, in some situations, the avoidance of disposal costs. In this system, recycling is successful when:

- Collection of recyclables is convenient and efficient
- Processing facilities are available within reasonable distance from point of generation
- Customers see a demonstrated financial incentive in recycling
- There is a strong market for the commodity being recycled
- Sales revenues exceed collection, processing and transportation costs
- Adequate funding for education and technical assistance is available

Many discrepancies exist between the traditional economic system and the ideal recycling model:

- Collection in rural areas may be neither efficient nor cost effective
- Demand and market prices vary considerably, and sales revenues may not consistently cover costs of recycling
- Municipal public programs that attempt to recycle a broad range of commodities have to be balanced with private businesses that selectively take the high-value commodities
- Processing facilities may not be available or may not attract necessary investment for state-of-the-art technology
- Funding for education and technical assistance to businesses has been significantly reduced
- The broader environmental benefits derived from recycling are often not understood and certainly not factored into the economics of recycling operations

Types of Barriers to Recycling

A number of regional factors that currently influence the success of recycling in urban and rural areas of Washington were identified in issue paper #11 "Recycling." These regional differences include:

- Economies of scale, related to population density and the level of recycling services and facilities that can be economically supported
- Distance from communities to processing facilities and markets
- Cost of marketing, and developing markets for, recycled materials
- Availability of education and technical assistance resources
- Absence or presence of strong public/private sector partnerships

The Recycling issue paper (#11) suggests that barriers to recycling can be characterized as financial, regulatory, political, logistical, and community-based. The workgroup participants for this paper also independently grouped barriers to recycling into the following categories: infrastructure and markets, acceptance of recycled products, manufacturing design for the environment, limitations in current funding options for solid waste programs, and the distribution of costs and benefits in disposal and recycling. Barriers to recycling are here considered within the following categories: financial, regulatory, political, logistical, and community-based.

Financial Barriers

Two types of financial barriers to recycling are 1) funds derived from tax and regulatory structures, and 2) funds derived from public funding or private investments. Because these funds are generated in support of the present solid waste system, they create an overall barrier to recycling. This is because increasing the recycling rate will ultimately diminish the waste to landfill option on which this funding depends.

In the broadest sense the financial framework for recycling is impacted considerably by federal, state, and local financial policies, tax laws or subsidies that may favor one industry over another, or that reward the use of virgin resources over material re-use. These issues are discussed in detail in the attachment “Tax and Subsidy Barriers to Recycling and Sustainability” by Sound Resource Management (Appendix B).

Traditional accounting practices and pricing for waste disposal and recycling, based on the existing market system, may create market prices for these services that act as financial barriers to recycling. The cost for waste disposal can be lower than the cost for recycling. This is because such pricing leaves out important information about human health and environmental impact costs.. Appendix A includes an analysis that partially examines the inclusion of external costs for curbside recycling versus garbage collection and disposal.

Another barrier to effective recycling is the need for increased investment in state-of-the-art product separation and processing technology, so that recycled materials are more cost-competitive with virgin resources. Although there are now encouraging examples of new investments being made as business opportunities are realized, this trend could perhaps be helped by a supportive tax structure or subsidy. For instance, smaller communities may be able to support the operating costs of composting but lack the capital to build the facility.

Public funds for education regarding the economic and environmental values in recycling have decreased. This is a critical need that may not be fully met by private industry. For example, it has been demonstrated that recycling most construction waste can pay for itself in urban areas where processing facilities are often available. If more public funds for education were available this opportunity to increase recycling would be more effectively communicated.

Closed-loop recycling includes the purchase of recycled content products. Barriers to purchasing recycled content products may include:

- Lack of acceptance by consumers of recycled content goods
- Lack of specifying recycled content products by state and local governments
- Increased price for these goods

There is a perception that citizens increasingly oppose taxes while demanding higher levels of public services. Local government officials are faced with determining funding priorities in this environment. The result of this situation is that recycling and other solid waste management programs become low priorities, especially in small rural communities. Also, many jurisdictions support comprehensive programs through disposal (tip) fees. Statewide, 95% of county solid waste revenues come from disposal fees and reserve fund balances.[35] Increased recycling and waste reduction programs cost money but also reduce disposal revenues, placing these jurisdictions in a financial and programmatic bind. Moving to non-disposal funding sources has been stymied by political opposition to what are perceived as new (rather than replacement) fees.

Regulatory Barriers

There is legal precedence that limits the ability of local or state jurisdictions to participate in direct support of market development activities for recycling industries, see Appendix B, "Tax and Subsidy Barriers to Recycling and Sustainability." Also, under federal law commercial recyclables are defined as a commodity and cannot be regulated by state or local government.[36] Private companies do not tend to invest in commercial recycling programs in rural areas because collection costs are very high. Although local governments could provide commercial recycling collection services, they may encounter financial barriers as well.

Economic efficiency of recycling collection in unincorporated areas may be impeded by the fact that counties can have difficulty in establishing innovative collection programs. While a county does have the authority to directly contract the collection of recyclable materials from residences and from drop boxes, curbside and drop box collection service in rural areas is unlikely to be cost effective unless it is included in the service provided by a certificated garbage hauler. In that case, the collection rate structure approved by the WA Utilities and Transportation Commission (WUTC) will be consistent with the minimum level of recycling services established in the county's solid waste management plan (RCW 81.77.030). Establishing any major change to a recycling collection program conducted by a certificated hauler may involve a county amending its solid waste plan and the certificated hauler seeking new rates through the WUTC.

In counties where paying for recycling is mandatory, the current WUTC residential rate-setting process includes a deferred accounting methodology. This method returns sales revenue from collected recyclables to the customer as an offset to the mandatory collection costs. Legislation recently passed, SHB2308, allows regulated companies, in addition to their guaranteed revenue, to keep up to 30% of the additional revenue sharing instead of giving commodity credits to customers. The legislation is intended to provide a monetary incentive for the private solid waste collection companies to increase the amount of material they recycle, and to encourage upgrading the quality of recyclables.

Other findings of the Recycling Assessment Panel[37] suggest that local permitting and Ecology/Health jurisdiction regulations may un-necessarily restrict the establishment of certain industries, or restrict on-site construction job recycling. Recycling facilities will need to accommodate an increase in range of recycled products.. Revising the building codes will facilitate the use of recycled materials as building materials.

Past Political Barriers

Political barriers in the past have included:

- The difficulty of identifying and modifying federal tax and subsidy policy to provide a level playing field for re-use and recycling industries compared with virgin materials and extraction industries
- Existing tax programs that create impediments to launching new recycling-based industries, such as capital gains status for timber sales instead of ordinary income status, which results in significantly lower tax rates.
- The political difficulty of raising or creating new taxes and fees when citizen initiatives are encouraging political officials to go in the opposite direction
- The absence of enough strong public/private sector partnerships between local government, collection companies, environmental groups, and waste associations
- The absence of a clear, widely understood rationale for waste reduction and recycling

Political action may be required to support changes in regulations and in the financial and social environment in which recycling has to compete. These past political barriers should be examined to determine which should be addressed in order to support future recycling efforts.

Logistical Barriers

Logistical barriers include factors that affect the physical collection and processing of recycled materials. These may include:

- Design and manufacturing policies that enhance product-recycling capability have not been implemented by most industries or encouraged by regulation, such as ease of disassembly and component content identification
- Manufacturers do not receive feedback regarding recycling, disassembly or design of their product at the end of its life. This inhibits design for recyclability and durability
- Contract product specifications often specify a source material rather than a performance specification for the product; e.g. Department of Transportation specifications for landscaping materials may exclude the use of biosolids/yard waste composting materials
- Low population density communities have limited recycling options due to the distance to regional industrial centers
- Inconvenient collection methods discourage participation, e.g. drop boxes instead of curbside service, and unnecessarily complex sorting requirements
- Transportation costs and distance to markets (local, regional or global)
- Absence of local or regional reprocessing industries for specific materials
- Technology is either not available or not cost-effective for recycling certain commodities

Community-based Barriers

Many of the barriers identified above may also be considered community-based barriers. Several additional community-based barriers are highlighted below:

- Lower priority for recycling compared to other more pressing demands for financial support in many communities
- Reduced awareness of the continuing need to reduce waste for disposal, enhanced by the existence of regional landfills (out of sight, out of mind), and unawareness of the continuing need to reduce waste in general and to participate in recycling
- Significant lack of funding for education and technical assistance needed to implement broad based programs
- Difficulties with source separation when consumers are asked to make difficult choices between apparently similar commodities; e.g. recycling codes on plastic products are frequently very small, difficult to find and hard to read, and recyclability may depend on whether the product has been blown or molded
- Difficulty in establishing local recycling-based industries in rural areas
- Lack of competitively priced products that incorporate recycled materials; barriers include lack of education and technical support for recycled products, concern about quality, and absence of local codes or UBC guidelines that encourage the use of recycled products is this included elsewhere?
- Impaired ability for local jurisdictions to enforce existing legislation such as outdoor burning restrictions, illegal dumping and littering
- Lack of state resources and leadership to support local community programs[38]
- Individual household costs to recycle which include source-separating time, and storage space

Section 3 Summary

The barriers described in Section Three may not fall neatly into any one category and are not single-issue problems. The future challenge for local communities and their elected leaders will be to set criteria and determine which, if any, of these barriers they are willing to tackle, either alone or with regional cooperation, and which have a reasonable chance of being solved by local action.

Change to the financial/legal/political system to make recycling and other sustainable solid waste practices more viable should be studied. At the state level, support for change must include the legislature, agencies, or both. This may include changes in regulation and financial incentives for recycling-based industries. The role of the State Solid Waste Advisory Committee, solid waste and recycling trade and industry organizations, and other groups must be identified, recognized and supported. Political action may be required to support changes in regulations, and in the financial and social environment in which recycling has to compete. Regulatory barriers must be examined to see which need to be addressed to support future recycling efforts. Logistical barriers need to be studied and addressed by the appropriate sectors. Community-based barriers should also be studied and addressed by the appropriate sectors.

Section 4:
Conclusions and Recommendations for Solid Waste Costs and Barriers to Recycling

Solid waste managers need to move toward sustainable management of residuals. This includes the use of full-cost accounting, internalizing external costs as much as possible, and working toward removal of barriers to recycling. Appendix A provides an example of possible price correction for curbside recycling when considering some of the broader issues of sustainability.

Section One suggests that when external costs are not fully reflected in the market price for a product, the resources used for the product can be undervalued and may not be used efficiently. It shows that it is possible to internalize external costs once they are identified and get results using our economic system in correcting the prices of goods. When we expand the scope of cost-benefit analyses, we can evaluate the positive and negative impacts of our resource use and materials management options.

Section Two contends that there are tools available to help us identify some of the external costs of managing certain products throughout their lives. Some of these external costs include manufacturing and transportation emissions, natural resource degradation, and energy consumption subsidies. Quantifying the impacts of pollutant emissions, natural resource use and energy consumption can be useful in the solid waste system.

The barriers described in Section Three may not fall neatly into any one category and are not single-issue problems. The future challenge for local communities and their elected leaders will be to set criteria and determine which, if any, of these barriers they are willing to tackle, either alone or with regional cooperation, and which have a reasonable chance of being solved by local action.

Decisions about how much and what type of recycling and other diversion should be provided in a given area can be better made after considering the following work:

- Gather more comprehensive life-cycle analysis of materials,
- Make decisions about solid waste management while considering the costs of solid waste using a more comprehensive model making use of sustainability principles,
- Evaluate tools such as the life cycle inventory for use as a policy development tool for resource management,
- Study ways to ensure that long term external costs are quantified and included in disposal fees where appropriate.
- Governments lead by example through purchasing recycled content, and
- Use information to affect consumer and corporate behaviors, for example, by using LCA to demonstrate savings from cost avoidance, or by participating in national stewardship initiatives as suggested in Issue Paper 7.

In a broader context, this paper suggests that the focus ultimately lies in creating products in a manner that conserves natural resources, minimizes waste, is compatible with biological processes, and limits the use of materials that create significant negative impacts on the ecosystem.   Correcting the market failure would affect pricing signals in such a way that costs of goods would reflect what is and what is not sustainable.

To date, the free market has been highly successful in boosting innovation, production, and living standards. Critiquing how it might be amended to be more successful at producing a sustainable economy, and identifying what part the solid waste industry and regulatory agencies play in creating these changes are critical next steps. At present, this issue paper is simply a beginning of the discussion of the economics of sustainability in the solid waste system. Further investigation and research is needed to refine the methods used in this state planning process.

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Appendix A
Single-Family Residential Curbside Recycling Case Study

Introduction and Purpose

This case study was conducted to compare current residential single-family curbside recycling programs in Washington against the *hypothetical* alternative of putting currently recycled materials back in the garbage. This hypothetical alternative was selected for illustrative purposes only, and is not being considered as a viable option for the future. The work group chose to perform this case study for several reasons.

First, this choice is complementary to the dual nature of the issue paper that encompasses both barriers to recycling and solid waste system costs. Second, there were relatively good information sources within the work group and from an EPA contractor to collect and analyze curbside recycling performance in Washington. Third and finally, there is a common policy perception that recycling costs more than it is worth and the work group believed that a case study on curbside recycling might shed some new light on those perceived costs

Washington State has historically achieved good recycling progress but has not reached the 50% goal set by the legislature. Some commodities, such as lead-acid batteries and aluminum cans have relatively high recycling rates, much higher than 50%, but many other commodities have recycling rates much lower than 50%. This case study examines some of the potential flaws in the economic pricing system for recyclable materials.

The study examines estimated external costs for a limited number of the environmental impacts from residential curbside *garbage* collection and disposal compared with those same impacts from residential curbside *recycling,* using the Life Cycle Assessment model. These impacts are mainly from emissions of 27 environmental pollutants: airborne releases of ten pollutants and waterborne releases of seventeen pollutants.

This case study demonstrates that it is possible to quantify indicators of sustainability. and it provides a sound basis to perform a more robust and definitive analysis. It is important, however, to recognize that the study was not intended to be exhaustive. For instance, the limited level of analysis cannot support specific decisions such as changes in rate design without further analysis.

This document is structured as follows:

1) Methods
2) Limitations
3) Results
4) Internal Costs & Benefits of Curbside Recycling versus Landfilling
5) External Costs & Benefits
    a) Solid Waste Collection, Processing and Landfilling
    b) Recycling Collection, Processing and Hauling
    c) Upstream Impacts
    d) Recycling versus Landfill Summary
6) Combining Internal and External Costs & Benefits

a) Recycling versus Landfilling
b) Recycling versus Waste-To-Energy (WTE)
7) Comparison of External Costs by Recycled Material
8) Using Energy to Estimate Environmental Impacts
9) Conclusions

There was significant effort to collect accurate information from WUTC files and local government records to assemble a reasonable estimate of recycling levels by commodity in four demographic areas of the state. To determine how findings might vary according to population density and other demographic and recycling program differences among various areas of the state, this case study categorizes data and results for the state into four regions. These demographic areas are:

- Urban/suburban areas west of the Cascade Mountains crest (Urban West)
- Urban/suburban areas east of the Cascade crest (Urban East)
- Rural areas west of the Cascade crest (Rural West)
- Rural areas east of the Cascade crest (Rural East)

The state's estimated 1,575,000 one-unit housing structures as of April 2000 are distributed among the four regions in order of population:[1]

- 828,000 or 52.6% are in the Urban West
- 401,000 or 25.5% are in the Rural West
- 189,000 or 12.0% are in the Urban East
- 157,000 or 9.9% are in the Rural East

This case study uses pollutant amounts from the EPA Decision Support Tool (DST) in combination with the range of costs for these pollutants provided by other studies shown in Table 4 of this Issue Paper. These monetary estimates for dollars per pound of pollutant are drawn from four studies and market transactions in pollutant emission permits that vary largely in their assignment of values, as well as in the scope of pollutants included in the study. Because the EPA DST only quantifies 27 pollutants, the full range of 64 pollutants listed in Table 4 of the Issue Paper is not accounted for in the estimates in this case study. Of the 27 pollutants in this case study, the lowest and highest dollar values of each pollutant were used to calculate a range of external costs. The lowest external cost for each pollutant was aggregated into "low-end" environmental costs. The highest external cost for each pollutant was aggregated into "high-end" environmental costs.

<u>Methods</u>

The case study is based on information gathered from numerous counties and cities across the state, from Washington Utilities and Transportation Commission staff, from research conducted by Washington Department of Ecology staff and Sound Resource Management Group staff, from members of the Issue Paper No. 10 Working Group, and from Research Triangle Institute (RTI) staff.[2] RTI used its Municipal Solid Waste Decision Support Tool (DST) model, developed in cooperation with the U.S. EPA, to calculate impacts on energy use and on emissions of ten air and seventeen waterborne pollutants as a result of recycling versus disposal of residuals. For disposal tonnage processed through Spokane's waste-to-energy (WTE) incinerator, EPA's global warming model was used to add in impacts of reduced carbon sequestration for the comparison with curbside recycling.[3]

The DST is an analytical tool containing the most well-researched, peer-reviewed municipal solid waste life-cycle information for the United States. The EPA developed this tool for solid waste decision-makers through a multi-year consensus process of academic and industry representatives. Because the pollutants included in this analysis are limited in scope, the magnitude of impacts is conservatively estimated.

This methodology compares environmental impacts and costs using the same quantities and composition of waste materials as they are managed through recycling and disposal. This methodology does not address the issue of average versus marginal costs. Most data gathered for this study reflects averages, both for internal full costs and for the limited external costs covered by the case study.

<u>Limitations</u>

It is not possible to perform a straight-line extrapolation from zero recycling to the present level for the costs and benefits between these two points. The cost to increase the level of recycling one commodity cannot be applied to another commodity. Similarly, the level of analysis in the case study cannot be used to project changes in the cost and benefits for different levels of recycling.

Average costs are the total costs divided by the number of units you are measuring, for instance, dollars per ton. Marginal costs are more closely associated with the concept of variable costs discussed in the Issue Paper. A marginal cost is the amount by which total costs increase when quantity increases by one unit. For example, if you are currently recycling one hundred tons of aluminum per year, the marginal cost is the additional cost associated with recycling the one hundred and first ton. Marginal costs are important to consider in economic analyses because they indicate when it is appropriate to increase or decrease a certain activity. Because we are only comparing the costs of our current recycling rates with the costs of not recycling, this Issue Paper does not include any marginal cost analysis. Additional work would need to be performed to estimate the incremental differences in cost and benefits for other recycling levels.

In the case of both external and internal garbage collection costs it is difficult to empirically determine what portion of garbage collection costs are saved by managing the materials through curbside *recycling* collection rather than curbside *garbage* collection. Certainly picking up a smaller quantity of garbage must to some extent reduce route times, trips to the transfer station, fuel use, maintenance costs, and other costs associated with truck usage. For purposes of this study, when comparisons are made between the costs of recycling and the costs of disposal, a best professional estimate assumes that 25% of external environmental impacts and costs for garbage collection vary directly with collection quantities. This 25% of garbage collection and transfer environmental impacts and external costs is counted as impacts and costs that are avoided by curbside recycling. The internal cost comparisons between recycling and disposal reported for this study assume that recycling does not reduce the internal costs of garbage collection and transfer at all.

The scope of the case study was not exhaustive. For instance, there was no attempt to quantify the cost to households for any additional effort required to perform curbside recycling. Similarly, no effort was made to quantify the household costs associated with a non-curbside recycling scenario. It is possible that factors such as these could materially affect the results of this case study. If further development of the analysis model is pursued, the selection and refinement of the most important factors to examine will be warranted.

It is important to understand the significant limitations that qualify and limit results from the case study. Specifically:

- Environmental impacts are calculated for only 10 air and 17 water pollutants. Air emissions of mercury plus air and waterborne emissions of dioxins are three important examples of pollutant emissions not included in this case study.

- By comparison EPA's annual Toxics Release Inventory currently includes information on releases for 644 toxic chemicals and chemical compounds.[4] In addition, the National Research Council has estimated that more than 70,000 chemicals are used in commerce.[5]

- Even for these few pollutants, estimates of external costs for each pollutant are quite difficult to compute precisely. As a result, studies using differing methodologies have obtained very divergent estimates. This uncertainty regarding the economic cost of environmental impacts is reflected in external costs reported in this case study by showing both the low and high ends of external cost estimates.

- The case study did not address impacts on habitat, biodiversity, resource conservation or ecosystem productivity from energy and raw material acquisition activities such as drilling, mining and logging that are required to support virgin-content manufacturing and, typically to a much lesser extent, recycled-content manufacturing.

- Curbside programs that provided information for the case study do not include all curbside programs in the state. Those that did provide data were often unable to provide all the information requested, especially with respect to cost and truck collection route characteristics. As a result, information on certain parameters, most importantly cost, housing density and truck travel distances/times, are not representative of every curbside program in Washington state.

Results

The analysis focuses in part on external costs from manufacturing products using virgin raw materials compared with manufacturing the same products using recycled materials. External costs from virgin- versus recycled-content product manufacturing are often referred to as the "upstream" impacts of waste disposal versus recycling. For more discussion on external costs and upstream impacts please see the main issue paper (Issue Paper 10).

This report uses the term "upstream" to refer to both virgin raw materials acquisition and to manufacturing of virgin-content products. Upstream impacts include manufacturing of recycled-content products, however, acquisition of recycled materials for use in manufacturing occurs through the solid waste system. The environmental impacts of materials acquisition for recycled-content manufacturing are, therefore, included among solid waste system impacts, rather than among the upstream impacts.

This study calculated the average quantities recycled per single-family household in each region on a monthly basis for those that subscribe to curbside garbage collection and have access to curbside recycling. It is important to understand that some of these households that have garbage collection service may not participate in their curbside recycling program. However, the recycling truck either does pass, or could pass, in front of their house while running its regular curbside recycling collection route. Therefore, all houses are included in the study where curbside recycling could be collected.

As shown on Figure A-1, average quantities recycled per household amounted to 56 pounds per month in the Urban West, 29 pounds for the Rural West, 26 for the Urban East, and 19 per month for Rural East households. Composition also varied among the regions, with the Urban East collecting virtually no mixed paper and the Rural East collecting virtually no glass. All regions collected newspapers, cardboard, aluminum cans, tin-plated steel cans, PET bottles and HDPE bottles in their residential curbside programs. The west regions also collected a little scrap metal.

Quantity and composition data for curbside recycling of about 617,000 single-family households in the Urban West and 107,000 households in the Urban East were collected and analyzed. Sample coverage in rural areas was much less comprehensive, amounting to 66,500 households in the Rural West and just 4,500 households in the Rural East. Table A-1 illustrates the sample size compared to the total number of single-family households in each region, as well as the sample percentages of that total. The low coverage in rural areas was due mostly to lack of curbside recycling availability; lack of reporting on some programs may also have decreased the low coverage in rural areas.

Table A-1. Sample Size for Single-Family Curbside Recycling Collection

Region	Sample Size	Total Single-Family Households	Sample as a Percent of the Total
Urban West	617,000	828,000	74.5%
Rural West	66,500	401,000	16.6%
Urban East	107,000	189,000	56.6%
Rural East	4,5000	157,000	2.9%
Total Statewide	795,000	1,575,000	50.5%

Other data in the sample used in RTI's DST model included distance and time on collection routes between successive stops. Estimated average distances between recycling truck stops varied from 75 to 88 feet for urban areas and 155 to 1,842 feet for rural areas. Estimated average travel times between stops varied from 11 to 30 seconds in urban and 49 to 58 seconds in rural areas.

Data on travel time and distance between successive stops on collection routes was available for only a subset of the total sample of single-family households. The data encompasses about 60,000 (10% of the sample) households in the Urban West and 13,500 (20% of the sample) households in the Rural West. Travel and distance data were available for 60% of the Urban East and 75% of the Rural East regional sample households.

Internal Costs & Benefits of Curbside Recycling versus Landfilling

Figure A-2 shows average internal costs for curbside recycling collection, processing. This includes the offset for revenues obtained from selling the collected recyclables after they have been processed to specifications of recycled-content product manufacturers. These average costs are based on data gathered for this case study from cities, counties, and Washington Utilities and Transportation Commission (WUTC) staff on customer fees for subscription-based curbside recycling, and on contract costs for recycling in communities which have curbside recycling bundled into their garbage collection fees.[6] The figure also shows landfill tipping fees that are avoided when materials are separated from the garbage and set out for curbside recycling collection.
Sound Resource Management Group (SRMG) calculated tipping fee savings per household based on a Department of Ecology study on average tipping fees per ton charged for disposal in each county in the state, and based on pounds recycled per household each month as shown in Figure A-1.[7] Figure A-2 demonstrates the concept that recycling costs more than landfilling when the analysis is limited to internal costs.

It should be noted that the curbside recycling cost data are based on a subset of the households for which quantity and composition data were gathered. In the Urban West region, costs for recycling were based on about 407,000 households (66%) of the households for which data on quantities recycled were gathered. Corresponding figures for the other three regions were 104,000 (97%) in the Urban East, 48,500 (73%) in the Rural West, and 1,000 (22%) in the Rural East.

As shown by Figure A-2, average internal full costs for curbside recycling vary across the four regions from a high of $2.78 per month in the Urban West to a low of $1.66 per household in the Rural East. Costs per household are the result of a complex interaction among amount collected from each household, travel time and distance on the collection route between households, shipping costs to market processed recyclables, and the composition of materials collected which determines average market value for materials picked up at each household.

Amount recycled each month drives savings in landfill tipping fees, as shown in Figure A-2. In addition, the Rural East region has a much lower average tipping fee, estimated at $32 per ton, than the other three regions where tipping fees average in the $70 to $80 range.

External Costs & Benefits

When evaluating only the internal costs, we found that, on average, recycling typically costs more than landfill disposal. However, the real external costs of each method should be included in a more complete analysis prior to making solid waste management decisions.

Solid Waste Collection, Processing and Landfilling

Figure A-3 portrays low and high estimates for some of the external environmental costs that result from garbage collection and transfer, as well as from landfill disposal for each geographic/demographic region. These costs are not captured in current market pricing for garbage collection and disposal services in Washington.

SRMG calculated external costs based on estimated emissions of the ten air and seventeen waterborne pollutants tracked for solid waste management methods through the EPA DST model, and on estimated costs to public health and the environment for each pollutant. Figure A-3 portrays costs using both a low and high cost estimate for the public health and global warming impacts of each pound of each pollutant emitted during garbage collection, transfer, hauling and disposal operations.[8] SRMG converted costs per pound for each pollutant to household costs per month in order to compare these external costs against internal costs by region.

As shown on Figure A-3, using high-end environmental cost estimates for the collection and transfer system vary somewhat among the four regions ranging from $0.24 per month in the Urban West to a high of $0.43 for the Rural West. At the low end of cost, external collection and transfer costs only amount to a few cents per household in all four regions.

Variation in high-end cost estimates among the regions may be explained by differences in amount of material collected, as well as by differences in distance and travel time between stops on the garbage collection route. Emissions appear to be more sensitive to distance and travel time between stops than to amount collected at each stop on the garbage collection routes. For example, under the assumption that garbage collection is picking up only what is currently being recycled through curbside programs, the Urban West garbage collection route picks up nearly twice as much per household compared with the Rural West, and nearly three times as much as the Rural East garbage collection route. Yet Urban West external collection costs are lower than either Rural West or Rural East costs.

Figure A-3 also portrays some of the estimated environmental costs of landfill disposal. For purposes of this case study, EPA's DST model assumed that landfill disposal was all via Subtitle D lined landfills using gas collection systems without energy recovery. This may not be an accurate assumption for every landfill used for garbage disposal by cities and counties in Washington State. Furthermore, in the Urban East 90% of refuse is sent to Spokane's WTE incineration facility. The comparison of recycling with WTE disposal is presented later in this report. Figure A-3 portrays case study results for the 10% of Urban East refuse that is landfilled. All waste in the other regions goes to landfill.

Environmental impacts of landfill disposal calculated using EPA's DST model depend directly on amounts landfilled from each household. As indicated in Figure A-3, estimated high-end external costs of landfilling vary between a low of $0.67 per month for each household in the Rural East, where the monthly disposal quantity is 19 pounds for each household, up to $1.90 for the Urban West where monthly disposal is 56 pounds per household. Low-end estimated monthly costs of the environmental impacts from landfilling amount to only one or two cents for each household in each region.

Environmental impacts of landfill disposal in EPA's DST model also depend on the amount of paper and cardboard that is landfilled. A higher proportion of paper raises the per pound environmental cost of landfilling slightly. In the Urban West, Urban East, and Rural West, paper and cardboard account for 69% to 75% of curbside recyclables. In the Rural East, by contrast, paper and cardboard account for 90% of curbside recyclables because most of the sample in that region is based on curbside programs that do not collect glass. Glass accounts for 19% to 23% of curbside recyclables in the other regions.

Recycling Collection, Processing and Hauling

Figure A-4 portrays low and high estimates for some of the external costs to the environment from recycling collection, processing and hauling operations. These costs are not captured in current market pricing for curbside recycling services in Washington.

As indicated on Figure A-4, recycling has external environmental costs that occur from pollutants released by collection vehicles, material processing facilities, and vehicles used to haul processed materials to manufacturers of recycled-content products. External costs reflect the environmental impacts of the ten air and seventeen water pollutants included in EPA's DST model. These external costs of recycling vary slightly among the regions on a per household basis from a low of $0.43 per month in the Urban East to a high of $0.56 in the Rural West. At low-end environmental costs, external public health and global warming impacts of recycling collection, processing and shipping operations only amount to four or five cents monthly per household in each region.

As with garbage collection trucks, environmental costs of recycling trucks depend more on distance and travel time between stops than on amount collected at each stop. On the other hand, impacts from processing facilities and from transporting materials to market vary more directly with recycling quantities per household. Due to time and budget constraints, the work group was unable to collect regionally specific data on average distances to actual markets for processed recyclables. Default values for shipping distances in EPA's DST model were used for all regions – 200 miles by truck for paper and cardboard, 90 truck miles for aluminum and tin cans, and 90 truck miles for glass and plastic bottles. Thus, the regional variations shown in Figure A-4 are due mostly to the variations in estimated travel time and distance between recycling collection route stops. Regional market distance variations can be significant for the economics of a specific business, but are typically less significant in overall efficiency than the on-route efficiencies and quantities set out per household.

Upstream Impacts

Figure A-5 portrays low and high estimates for some of the external costs to the environment from manufacturing products with virgin raw materials instead of manufacturing those products with recycled materials. That is, Figure A-5 shows additional external costs for making products with virgin materials compared with manufacturing products with recycled materials. These costs are not typically captured in current market pricing for manufactured products sold in the US.

The high-end estimates of external cost of using virgin materials rather than recycled materials to make products varies among the regions from a high of $2.57 per household per month in the Urban West to a low of $1.11 in the Rural East. Low-end environmental costs for virgin- and recycled-content manufacturing are essentially equivalent according to estimates for environmental releases calculated by EPA's DST model.

The variation among the four regions in high-end estimates of external upstream costs shown in Figure A-5 is partially due to variation in pounds recycled per household in the four regions. In addition, some of the variation is due to the relative absence of mixed paper in Urban East recyclables, the lower relative amount of cardboard in Rural West recyclables, and the relative absence of glass in Rural East recyclables. The importance of different materials in the additional upstream costs of virgin- over recycled-content manufacturing will become clearer when estimated environmental impacts for each type of recycled material are discussed later in this report.

Recycling versus Landfill Summary

Figure A-6 summarizes external cost estimates shown in Figures A-3, A-4 and A-5 to show the net benefits of curbside recycling over landfill disposal, as well as the substitution of recycled-content materials for virgin-content materials in manufacturing. At high-end estimates of environmental costs, curbside recycling and use of recycled-content materials has the net external benefits versus landfilling and use of virgin-content materials shown in Figure A-6 for the following reasons:

- Recycling avoids the additional external costs of virgin-content manufacturing (shown in Figure A-5) by substituting recycled materials in place of virgin materials to make products;
- Recycling avoids all of the external costs of landfill disposal and a 25% portion of the external costs of garbage collection (both shown in Figure A-3) and,
- Recycling only has to pay the external costs of recycling collection, processing and shipping (shown in Figure A-4).

At high-end environmental costs, curbside recycling's net savings in environmental impacts are worth from an estimated high of $4.06 per month for each curbside available household in the Urban West down to a low of $1.40 in the Rural East. Quantity recycled per household is the primary driver of curbside recycling's environmental benefits, with other variables playing a supporting or qualifying role as outlined in the discussion of Figures A-3, A-4, and A-5 above.

At low-end environmental costs per pound of pollutant emissions, recycling actually costs a few pennies more than landfilling. This is due to the estimate that curbside recycling collection and shipping operations have greater environmental costs than curbside garbage collection and hauling activities, at least in terms of the 27 pollutants tracked by EPA's DST when those pollutants are estimated to have low environmental costs. At low-end costs, landfill disposal has negligible environmental cost and virgin-content manufacturing is virtually equivalent to recycled-content manufacturing.

<u>Combining Internal and External Costs & Benefits</u>

Recycling versus Landfilling

Figure A-7 summarizes case study results by comparing internal costs against external benefits of curbside recycling over landfilling in each of the four regions. The internal net cost for curbside recycling in the each of the four regions shown in Figure A-7 was calculated by subtracting the avoided landfill tipping fee shown in Figure A-2 from the internal recycling cost (collection plus processing plus shipping costs minus market revenues) for each region also shown in Figure A-2.

Due to time and budget constraints, no internal costs for curbside garbage collection, transfer and hauling were gathered for this case study. To compensate for the lack of internal cost calculations, a value of zero was used as the avoided cost to collect, transfer and haul costs for garbage. In other words, for the purposes of this case study, it is assumed that avoided garbage collection, transfer and hauling costs amount to zero when material is collected curbside in the recycling truck instead of the garbage truck. Using the value of zero serves to underestimate the actual internal costs of garbage collection, which in turn decreases the estimated benefits of curbside recycling collection. The left most bars for each region in Figure A-7 (internal net cost of recycling) include a credit to recycling only for avoided landfill tipping fees; no credit is shown for avoided garbage collection and hauling system costs.

As indicated in Figure A-7, internal net costs for curbside recycling vary from a low of $0.73 per month for the Urban West to a high of $1.35 per household for the Rural East. The reasons for this variation were covered in the previous section's discussion regarding amount of materials collected, travel time and distance between successive stops on the curbside collection route, and tipping fees in the four regions.

Using high-end cost, the external net benefits of curbside recycling over landfill disposal were calculated for Figure A-6. These estimates are repeated in Figure A-7 as the third bar in each region to show that net external benefits exceed net internal costs for recycling versus landfilling in all four regions. Only in the Rural East is curbside recycling's high-end net environmental benefit close to the net internal cost of single-family curbside recycling. This is largely attributable to the fact that in the Rural East the average monthly amount recycled per household is only 19 pounds, and landfill tipping fees average only $32 per ton.

For the low-end environmental cost estimates for some of the external impacts of recycling versus landfilling materials, curbside recycling has a small cost (negative net benefit). When using the low-end environmental costs, there are no significant upstream external benefits for recycling and no significant environmental costs of landfilling to be avoided which would otherwise offset the environmental costs of having extra trucks on the road for curbside recycling operations. Additionally, the environmental impacts of curbside recycling's collection, processing, and shipping operations outweigh the environmental impacts of garbage collection and hauling in all four regions. These low-end estimates are developed using only the 27 pollutants inventoried in EPA's DST combined with the lowest available estimated dollar value for each of these pollutants.

Recycling versus Waste-To-Energy (WTE)

According to EPA's 1998 study on greenhouse gas emissions from management of solid waste, carbon sequestration "reduces greenhouse gas concentrations by removing carbon dioxide from the atmosphere. Forests are one mechanism for sequestering carbon; if more wood is grown than is removed (through harvest or decay), the amount of carbon stored in trees increases, and thus carbon is sequestered…recycling of paper products, for example, reduce(s) energy consumption, decrease(s) combustion and landfill emissions, and increase(s) forest carbon sequestration."[9]

EPA's DST model accounts for fossil fuel carbon dioxide emission reductions when recycled-content products replace virgin-content products as a result of recycling, or when fossil fuel energy generation is reduced by incineration of waste materials in a WTE facility. However, the EPA DST model does not account for avoided loss of carbon sequestered in forests when paper and cardboard are recycled in place of harvesting trees. This appears to be a significant shortcoming of the model, especially for comparisons of recycling with WTE incineration.

To account for carbon sequestration retained in forests due to paper and cardboard recycling, SRMG used EPA's spreadsheet model for calculating greenhouse gas impacts of waste management options.[10] The carbon sequestration estimates from the EPA spreadsheet were combined with the greenhouse gas emissions data from the EPA DST model to provide a more complete estimate of the impacts of recycling versus WTE.

Other than the addition of the sequestered carbon data to the EPA DST modeling results, the concept for Figure A-8 is the same as for Figure A-7. Because only the Urban East has a WTE facility, it is the only region represented in this comparison. The left most bar shows recycling's net internal cost in the Urban East at $0.85 per month for each household, the same figure shown for the Urban East in Figure A-7. Similarly, external net benefits summarize the external benefits related to avoided garbage collection, transfer and hauling and to upstream avoidance of virgin materials use. These benefits of recycling are offset by environmental impacts from recycling collection, processing and shipping operations. In addition, in the case of WTE disposal there is an additional offset to reflect the loss of energy generation when materials are recycled rather than incinerated in Spokane's WTE facility. In Figure A-7 avoided environmental impacts of landfilling were a benefit for recycling, whereas in Figure A-8 lost energy generation is an offset to recycling's benefits.

Figure A-8 portrays the results of this analysis in comparing curbside recycling with WTE incineration for the 90% of waste in the Urban East region that is managed at Spokane's WTE facility. As indicated in Figure A-8, at high-end costs for public health and global warming impacts of pollutants, curbside recycling's internal net costs at $0.85 per household each month are more than offset by recycling's external net benefits of $1.06. At low-end external costs, curbside recycling has a small negative external benefit due to lost energy generation through WTE and to the very small valuation on carbon dioxide emissions at low-end cost of $0.0002 per pound which makes carbon sequestration in forests from paper recycling almost valueless.

<u>Comparison of External Costs by Recycled Material</u>

The case study also examined upstream benefits from recycling eight different types of residuals:

- mixed paper,
- newspapers,
- cardboard,
- glass containers,
- tin-plated steel cans,
- aluminum cans,
- PET (polyethylene terephthalate) bottles, and
- HDPE (high density polyethylene) bottles.

This examination was confined to upstream benefits, because it is extremely difficult to allocate all collection and processing system impacts to specific types of materials.

Figure A-9 shows environmental benefits from reduced emissions of ten air pollutants and seventeen water pollutants for each ton recycled for the eight. To show the environmental benefits of carbon sequestration in forests from paper recycling, EPA's global warming model for municipal solid waste management was also used to augment the emissions data generated by EPA's DST model.

For the high-end estimates for the costs of pollutants, external benefits of recycling the various materials range from a low of $65 per ton for cardboard up to $1,684 for aluminum cans. For low-end environmental costs, newspapers have a negative external benefit, mixed paper has zero benefit, and cardboard has only a $3 per ton positive external benefit. Other materials have higher benefits ranging from $18 per ton for glass containers to $175 for aluminum.

The low values for paper in Table 4 of the Issue Paper reflect: 1) increased waterborne emissions of suspended solids and higher biological oxygen demand (BOD) for recycled-content versus virgin-content paper production, and 2) costs for suspended solids and BOD are the same for both low-end and high-end valuations for environmental costs. The latter fact is due to having estimates of costs for these two pollutants in only one of the four studies from Table 4 that were used to determine the range for environmental costs for pollutants for this case study.

The relative lack of data on environmental costs for waterborne pollutants compared with atmospheric pollutants is perhaps indicative of the need for further research. Further research also is needed on the environmental impacts of using mixed paper in manufacturing, and perhaps for other types of recycled paper. For example, for this case study, the DST model assumed that all mixed paper was recycled into magazines and junk mail-type paper products. By contrast, it is becoming increasingly common for mixed paper to be used in the manufacture of newsprint.

Using Energy to Estimate Environmental Impacts

Figure A-10 compares per household energy required to run the curbside recycling collection, processing and hauling system against the energy conserved by using the recovered materials in place of virgin raw materials to manufacture new products. Upstream energy conservation is directly related to the amount of material recycled by each household at which curbside collection is available, as well as to the composition of recycled materials since aluminum, for example, has much greater upstream energy conservation benefits than does, say, glass. At the same time, energy used for the curbside recycling system is relatively insensitive to the amount collected from each household.

Conclusions

This case study looks at external costs and benefits to help state and local governments and agencies make more informed and forward-looking decisions about how much to spend on waste reduction/recycling/composting (i.e.diversion) versus disposal, with an eye to increasing the sustainability of those decisions.

Because internal costs of recycling are in many cases not covered by the sum of revenues from selling recyclables and avoided garbage collection/transfer/disposal costs, the household or business or local government is faced with spending more in order to divert waste from disposal. On the basis of just internal costs alone, that may be seen as a bad decision.

However, looking at the ecological and sustainability benefits of diversion, one gets an entirely different answer. That broader view and vision might lead a decision-maker to spend more on diversion, even though it means a larger overall waste management bill (the sum of spending on diversion and disposal).

This does leave the question of how much more should be spent, and where the money should come from, to do the right thing for sustainability of the planet and future generations. Answers may involve national policies, changes in tax laws, and other factors outside the traditional solid waste arena. Obviously, such questions are beyond the scope of the case study or other parts of this issue paper work. But they are important points to consider in determining what a more sustainable solid waste management system might look like.

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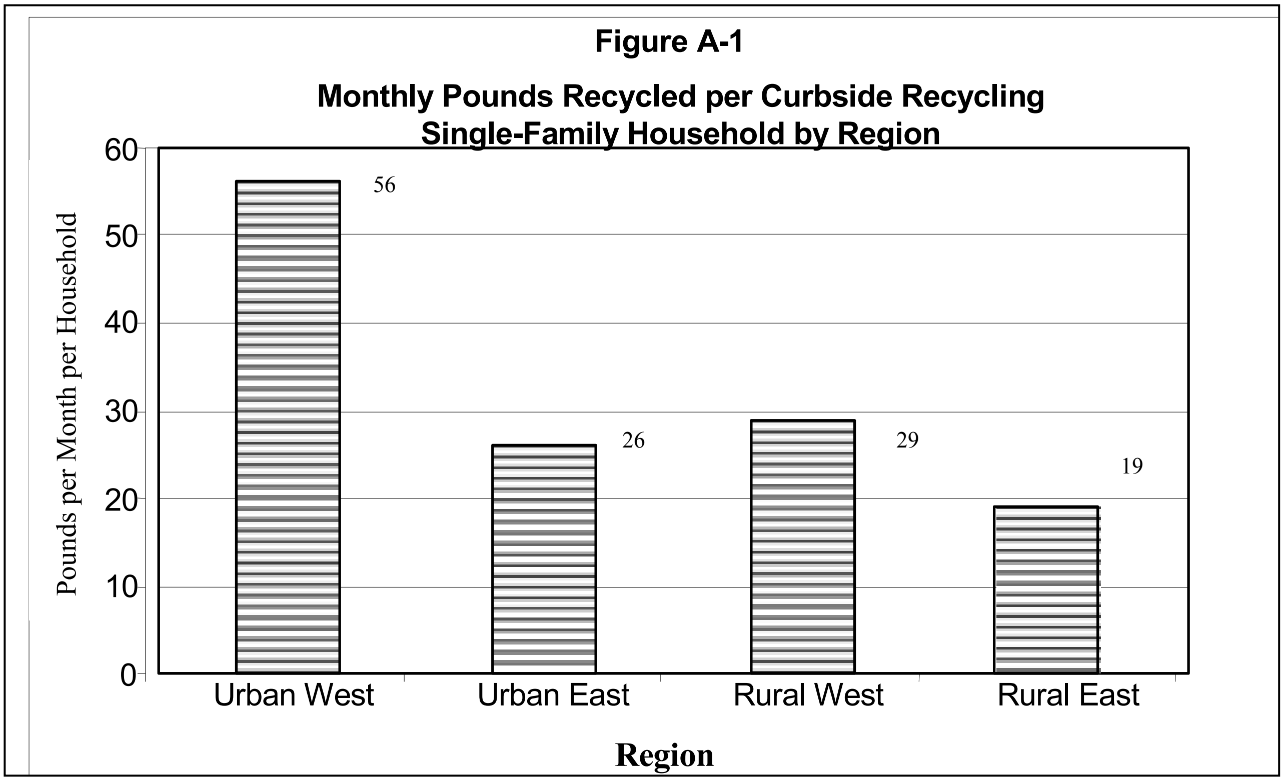


Figure A-1
Monthly Pounds Recycled per Curbside Recycling
Single-Family Household by Region
Pounds per Month per Household
60
50
40
30
20
10
0
56
26
29
19
Urban West
Urban East
Rural West
Rural East
Region

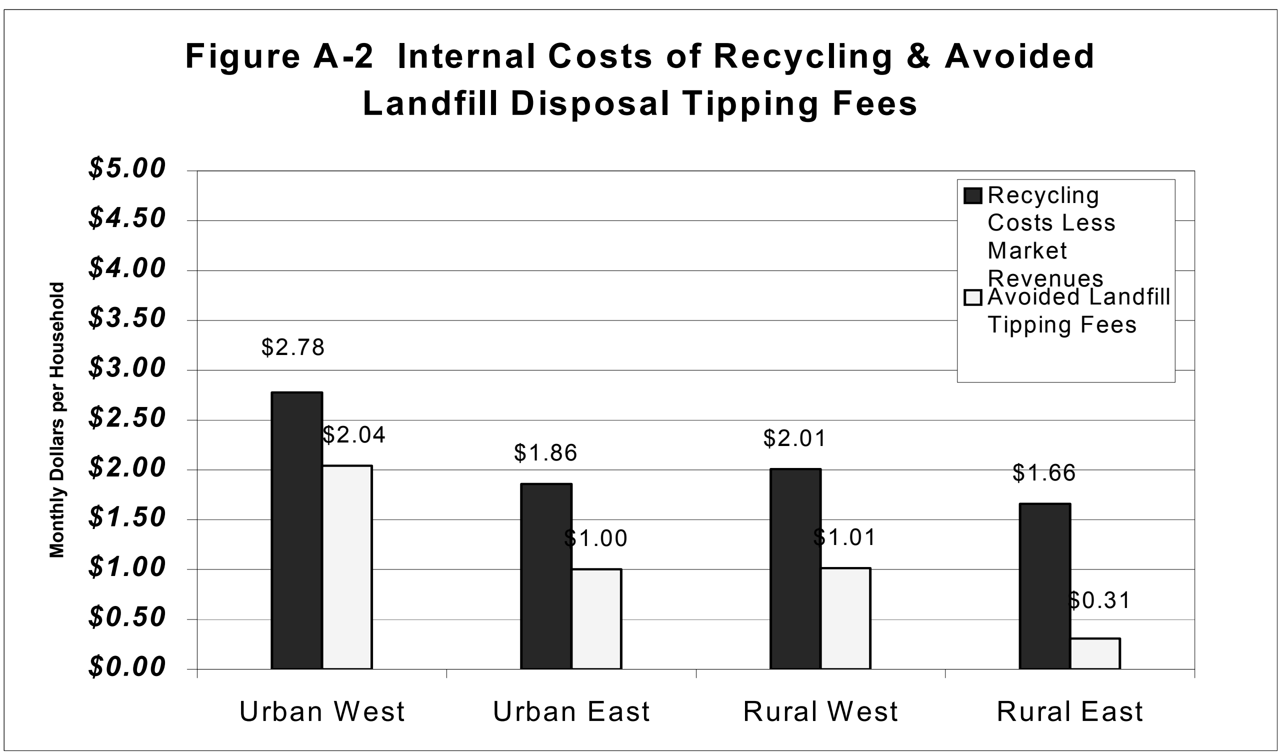


Figure A-2 Internal Costs of Recycling & Avoided
Landfill Disposal Tipping Fees
Monthly Dollars per Household
$5.00
$4.50
$4.00
$3.50
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
Recycling Costs Less Market Revenues
Avoided Landfill Tipping Fees
$2.78
$2.04
$1.86
$1.00
$2.01
$1.01
$1.66
$0.31
Urban West
Urban East
Rural West
Rural East

Figure A-3 Range of External Environmental Costs of Garbage Collection and Landfill Disposal

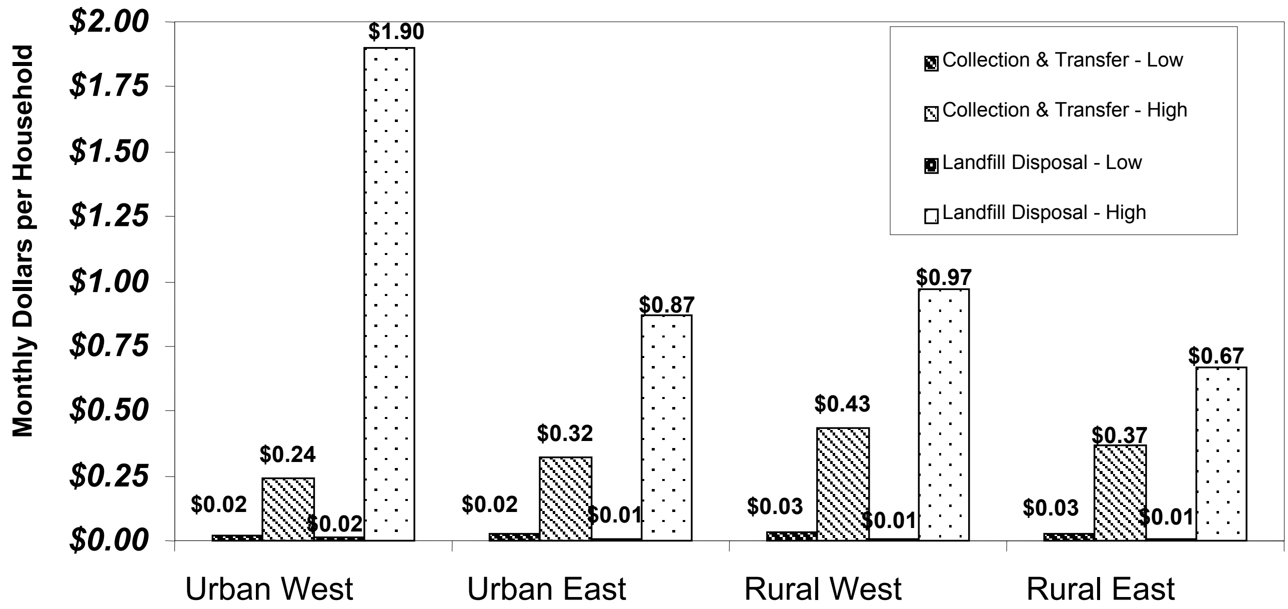


Figure A-4 Range of Estimated External Environmental Costs for Recycling by Region

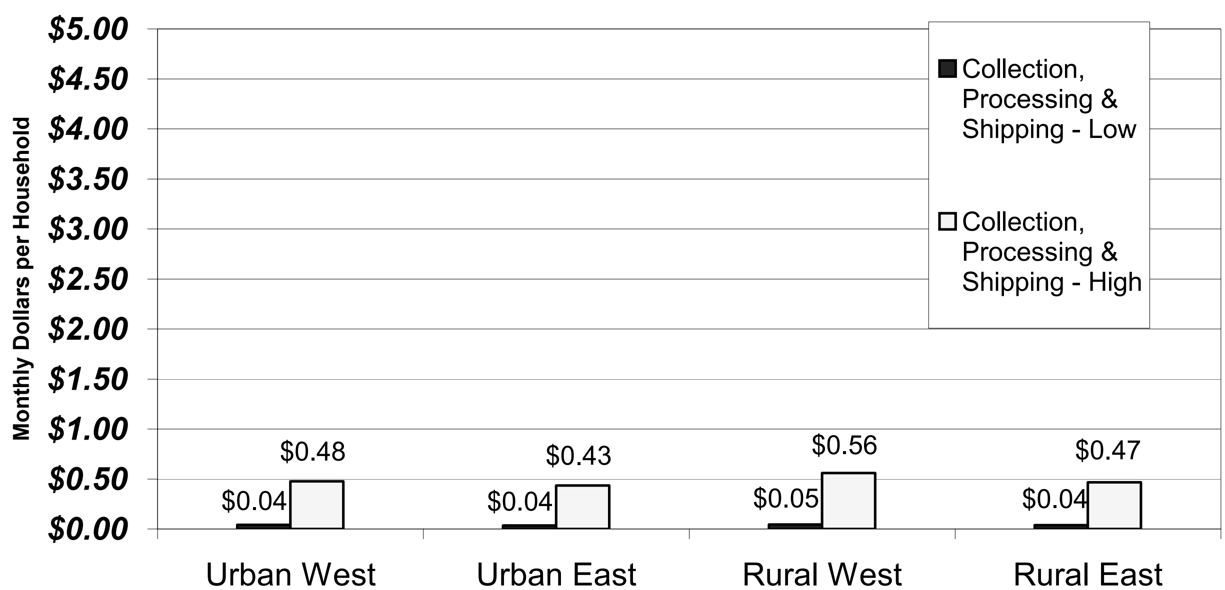


Figure A-5 Range of Additional Estimated External Costs of Manufacturing with Virgin vs. Recycled-Content Materials

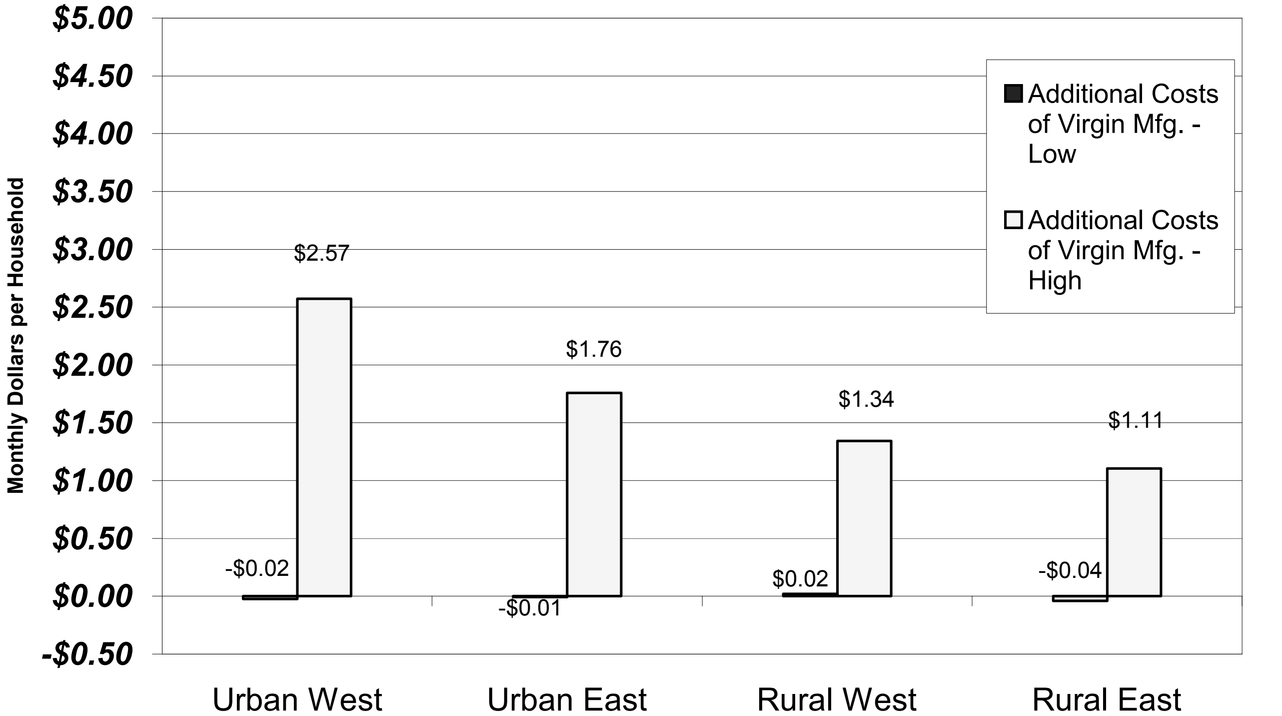


Figure A-6 Range of Estimates for External Net Benefits of Recycling over Landfill Disposal by Region

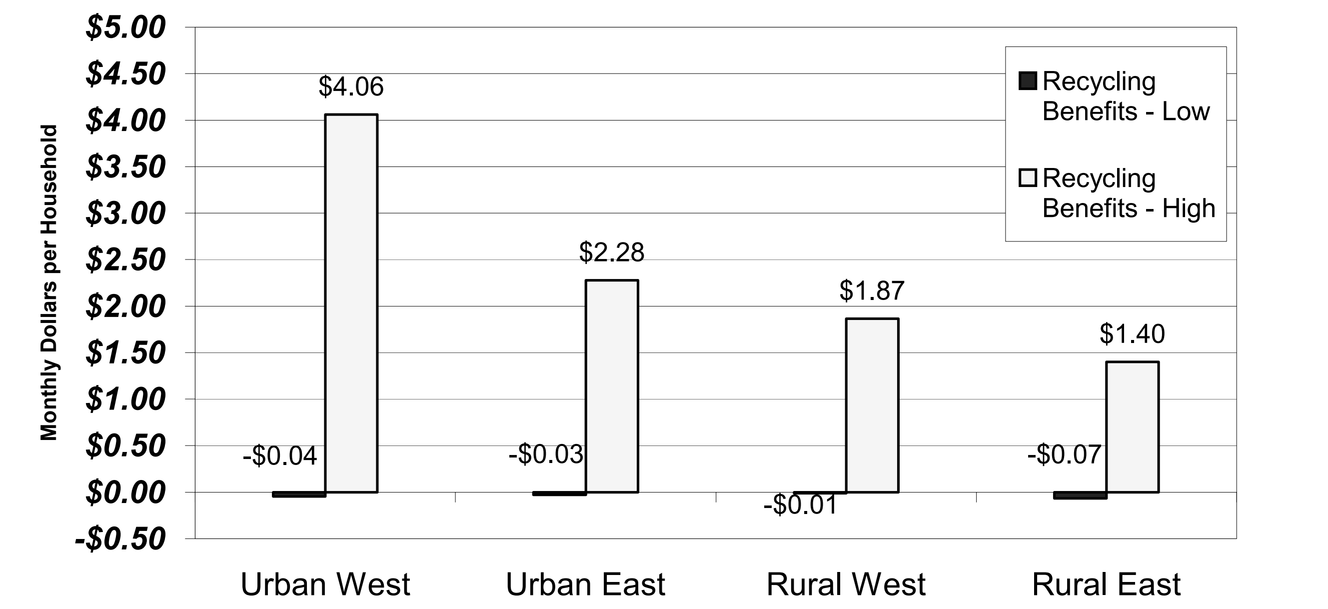


Figure A-7 Internal Net Costs and Benefits of Recycling over Landfilling

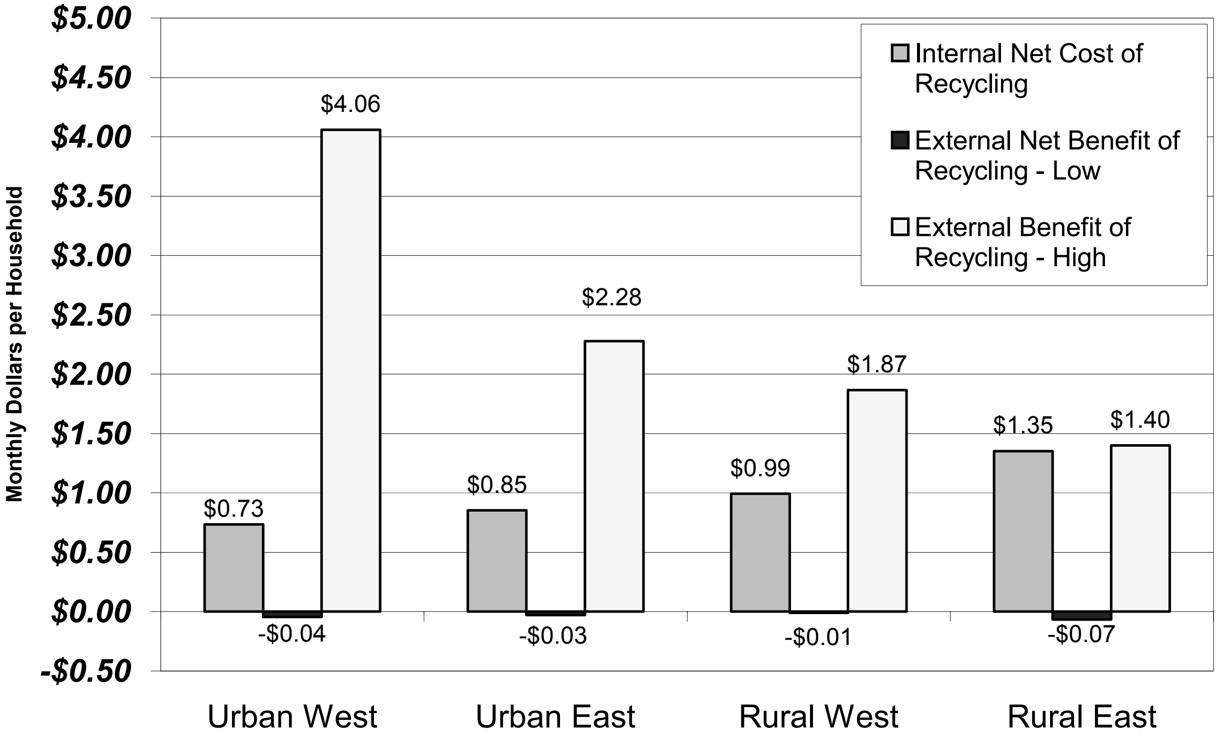
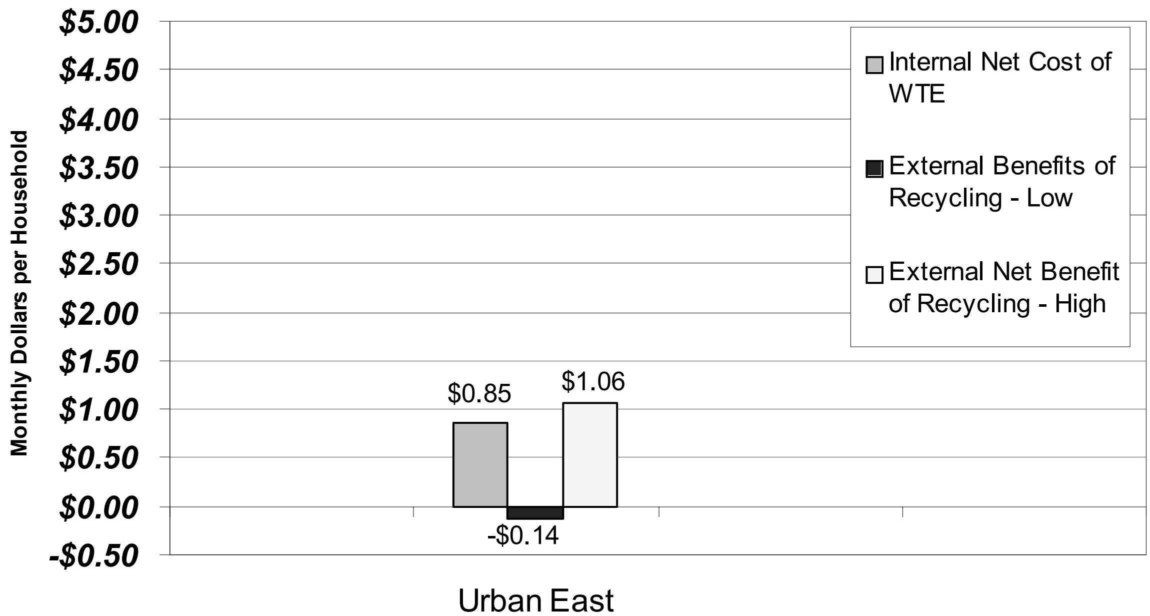


Figure A-8 Internal Net Costs of WTE vs. Range of External Net Benefits of Recycling



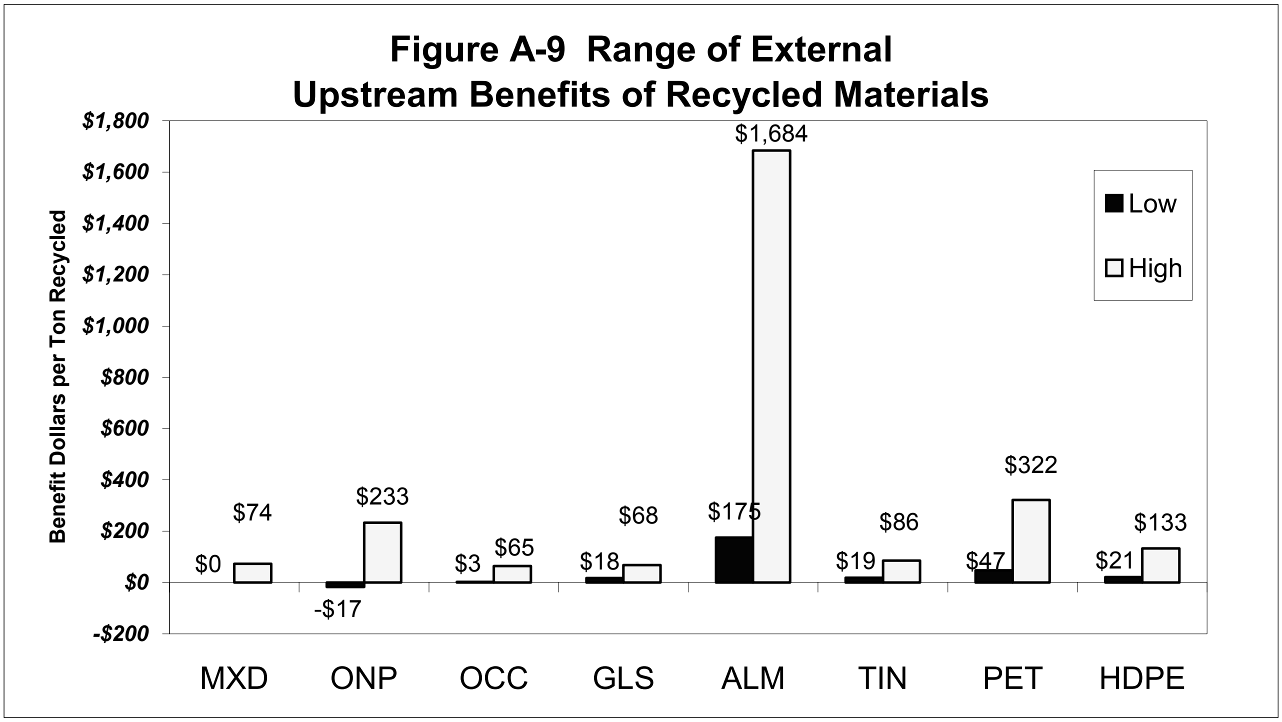


Figure A-9 Range of External
Upstream Benefits of Recycled Materials
Benefit Dollars per Ton Recycled
$1,800
$1,600
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
-$200
Low
High
$0
$74
-$17
$233
$3
$65
$18
$68
$175
$1,684
$19
$86
$47
$322
$21
$133
MXD
ONP
OCC
GLS
ALM
TIN
PET
HDPE

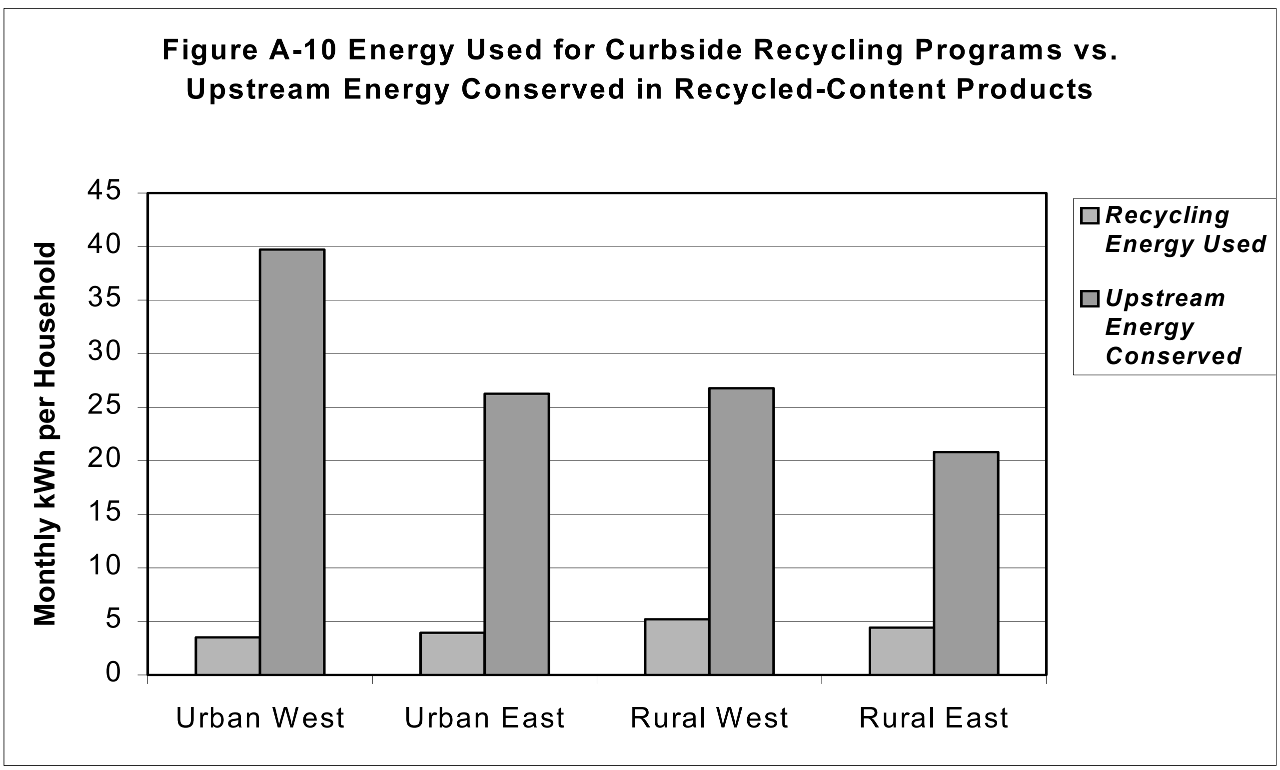


Figure A-10 Energy Used for Curbside Recycling Programs vs.
Upstream Energy Conserved in Recycled-Content Products
Monthly kWh per Household
45
40
35
30
25
20
15
10
5
0
Recycling Energy Used
Upstream Energy Conserved
Urban West
Urban East
Rural West
Rural East

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[1] *2000 Population Trends*, State of Washington Office of Financial Management Forecasting Division, September 2000, Table 7 – Housing Units by Structure Type for Cities, Towns and Counties, April 1, 1990 and April 1, 2000, pp. 28-32.

[2] Contact person for the DST at RTI is Keith A. Weitz, Center for Environmental Analysis, Research Triangle Institute, 3040 Cornwallis Road, Research Triangle Park, NC 27709; Ph: 919-541-6973; Email: kaw@rti.org

[3] *Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste*, US EPA, EPA530-R-98-013, September 1998.

[4] See http://www.epa.gov/tri.

[5] *Environmental Neurotoxicology*, National Research Council, National Academy Press, 1992, p. 2.

[6] Bundling (or embedding) is the situation in which the garbage collection service customer gets curbside recycling at no additional charge. This situation is sometimes described as being an "all pay" or "everybody pays" program because all garbage collection service subscribers pay for curbside recycling whether they choose to use it or not.

[7] *(Data adapted from) Solid Waste Facility Database.* Washington State Department of Ecology, 1999.

[8] *Specific Measures Used to Evaluate External Costs*, Sound Resource Management Group.

[9] *Greenhouse Gas Emissions*…, *op. cit*., US EPA, p. ES-4.

[10] *Calculating Greenhouse Gas Emissions With the Waste Reduction Model* US EPA, http://www.epa.gov/oppeoee1/globalwarming/actions/waste/usersguide.htm.

Appendix B
Tax and Subsidy Barriers to Recycling and Sustainability

Introduction and Purpose

Taxes and subsidies have long been used to influence human behavior. Placing a tax on an item or action may dissuade people from using that item or performing that action; granting a subsidy to an item or action may encourage the use of that item or the performance of that action. A new approach has been proposed by some economists that would reform the current tax system by integrating the long-term goals of sound economic growth, environmental quality and fairness. Some economists believe that by "shifting" the tax burden from "goods" to "bads," and reducing or eliminating subsidies (whether direct or indirect) for the use of virgin materials, society can create a more sustainable economy.

This appendix briefly looks at what exists in the current literature regarding the federal, state, and local tax and subsidy policies that impact recycling and the desire for a more sustainable economy, and then discusses some of the changes that have been proposed, such as the growing international trend to shift the burden of taxation away from productive activities and onto pollutants. This trend is rooted in the recognition that taxes not only raise necessary revenue for governments, but also, as mentioned above, discourage the taxed activity. When levied on productive activities, taxes place an extra burden on the economy, whereas when levied on pollution, taxes help to control pollution.[1]

Federal Level

At the federal level, many programs provide significant tax breaks and other subsidies for the use of virgin materials. This creates an uneven playing field for recycling and reuse businesses that must compete against subsidized competitors.[2] Favoritism for the virgin materials industries dates back to the 19th century when subsidies were intended to encourage the development of the West and to spur the national transition from an agrarian to an industrial society. Unfortunately, once ingrained into our societal fabric, such subsidies have been hard to remove.

In "*Welfare for Waste – How Federal Taxpayer Subsidies Waste Resources and Discourage Recycling*,"[3] fifteen direct subsidies are identified that negatively affect the use of recycled materials, creating barriers to a more sustainable economy. Subsidies identified as undermining recycling and reuse can be broken down into four categories: timber direct subsidies, hard rock mining direct subsidies, energy direct subsidies, and waste facility subsidies.

Timber Direct Subsidies include:

1) Capital Gains Status for Timber Sales – instead of treating the sale of timber as ordinary income and taxed accordingly, private timber owners are able to claim capital gains status for much of their capital or lasting assets, which include timber sales; thus, paying a significantly lower rate.

2) Below-Cost Forest Service Sales – U.S. Forest Service "commodity" timber sales program sells trees to companies at pricing below the costs of preparing sales and administering harvests; thus, timber is commonly sold below sustainable market value.

3) Forest Roads Construction – U.S. Forest Service reimburses logging companies' road-building costs through credits towards additional timber and sale prices reduced below the already low price.

4) Forest Service Salvage Fund – Insect-infested, dead, damaged or downed timber is sold by the U.S. Forest Service for a fraction of the cost of commercial-quality wood, with higher-value timber often mixed in to make the sale more attractive. The Forest Service retains the funds from salvage sales in the Salvage Sale Fund, creating an incentive to promote salvage sales since the funds are not returned to the U.S. Treasury.

Hard Rock Mining Direct Subsidies include:

5) 1872 Mining Law – minerals worth billions of dollars are taken from public lands by miners who pay no royalties for the minerals, only $2.50 - $5.00 per acre to obtain title from the federal government. Anyone may explore open public lands for hard rock minerals, including gold, silver, iron, copper, zinc and lead. Anyone filing a claim has an automatic right to extract minerals found there. Title to these public lands may be valuable for development purposes, too. Taxpayers are left the clean-up expenses.

6) Mining Percentage Depletion Allowance – permits mining firms to deduct a fixed percentage (usually 5 – 22%) from their gross annual income, instead of depreciating their actual costs at the rates required for other businesses. Overall deductions are not limited to the initial cost of the investment; thus, total deductions frequently exceed original investment costs.

7) Expensing Exploration and Development Costs – costs of exploration and development for locating valuable mineral deposits are deductible in the year the costs are incurred rather than over time. (see the Issue Paper for a discussion regarding the importance of time horizon and the discount rate)

8) Inadequate Bonding Requirements – since abandoned mines must be cleaned up at taxpayers expense, the federal government has begun requiring mining

companies to carry insurance bonding to cover potential cleanup costs; however, the bonding requirements are still not sufficient to cover clean-up costs and poorly enforced.

Energy Direct Subsidies include:

9) Percentage Depletion Allowance – a special percentage depletion write-off is granted independent oil companies not substantially involved in retailing or refining activities. They can deduct 15% of their gross income to reflect the declining value of the wells as they become unproductive. Combined with other subsidies for the oil and gas industry, the percentage depletion allowance subsidy often exceeds 100% of the actual value of the energy produced, encouraging the draining of domestic energy resources while discouraging the development of renewable energy and energy efficiency.

10) Intangible Drilling Costs (IDCs) – Oil and gas producers may deduct 70% of intangible drilling costs in the year they are incurred rather than as capital assets wear out or the oil is depleted.

11) Passive Loss Tax Shelter – allows investors in gas and oil production to use losses, deductions and credits to offset other income.

12) Alternative Fuel Production Credit – provides a tax credit for the production of alternative fuels extracted from such sources as slate and tar sands, as well as for synthetic fuels made from coal and gas from geo-pressurized brine. Most of the credit has gone to develop drilling and production technologies needed for hard-to-tap oil and gas reserves. This is not a credit for sustainable alternative fuels such as solar, wind and geothermal.

13) Enhanced Oil Recovery – oil companies investing in tertiary enhanced oil recovery operations are allowed a tax credit equal to 15% of their costs. Tertiary recovery methods include the use of chemical or thermal fluids, steam or alkaline flooding to extract otherwise inaccessible oil.

14) Bonneville Power Administration: Electric Power Subsidies for Aluminum Smelters – BPA sells subsidized electricity from a network of 29 federally owned dams and one nuclear power plant. Its low power rates have attracted over 30% of U.S. aluminum production to its service area. It sells the subsidized electricity at preferential rates to aluminum smelters and others.

Waste Facility Subsidies include:

15) Private Activity Bonds (PABs)– 70% of all bonds used to finance solid waste facilities are PABs, but most recycling facilities do not qualify for the bonds since they are targeted towards capital-intensive projects. Income earned on PABs is tax-exempt. Thus, PABs subsidizes the financing of landfills and incinerators.

The *"Welfare for Waste"* report also identified indirect subsidies that accrue to the virgin materials industry, and are, by their nature, harder to document and quantify. These include:

- Energy – unnaturally low prices resulting in cheaper virgin feedstocks
- Water – replacement for higher-priced energy; below or no cost water and wastewater treatment
- Transportation – building and maintenance of remote and major highways, inland waterways, port maintenance, marine safety and navigation programs
- Tax – bias towards capital-intensive investments as opposed to labor-intensive projects
- International – multilateral promotion of extraction industries, trade and aid favoritism, transfer pricing
- Unfunded External Costs – avoidance of pollution clean-ups, environmental damage, failure to incorporate cost of disposal

By providing subsidies to extract virgin resources, taxpayers end up losing money on undervalued, taxpayer-owned resources; providing welfare for private corporations; cleaning up pollution, eroded land, silted rivers, damaged ecosystems and hazardous waste sites in an even larger number than might have been created if subsidies had not encouraged more extraction; paying for disposal of companies' products when they are discarded; encouraging substitution of capital-intensive processes that extract materials instead of more labor-intensive industries that conserve them; and, paying more for recycling that could have been competitive with or even less expensive than fairly priced virgin materials production.

State Level

When the Washington State Solid Waste Management Plan (SWMP) was last updated in 1990 it acknowledged that legislation should be designed to influence a change in the individual waste management behavior of every citizen. However, it noted that existing legislation would not ensure that all solid waste was managed in the most environmentally sound manner that protects human health and is consistent with the highest priority method under the State SWMP. The statutes as written at the time either did not mandate action in all cases or grant environmental considerations equally with economic considerations. These statutes have not changed substantially in the last ten years. Yet the mission statement called for solid waste to be managed in the most environmentally sound matter.[4]

One of the goals identified in *"Washington State Solid Waste Management Plan – Issue Paper No. 3, Solid Waste Legislative Review"* was: "Goal B: Solid waste financing functions on a stable basis and reflects the true costs of waste management. Costs include clean-up of past facilities, current operations (i.e., collection, recycling, separation of mixed wastes and monitoring) and future closure and post-closure activities." However, the Issue Paper stated: "Providing stable financing that reflects the true costs of solid waste management is quite problematical. It is difficult to determine what the "true costs" of waste management really are. Thus, this goal will be among the more difficult to realize. Legislation, however, is in place that will serve as a foundation for achieving it."

The Issue Paper went on to identify the need for stable markets for recyclable materials, with an emphasis on in-state markets. (Markets were dealt with in detail in Issue Paper No. 7 of the 1990 State SWMP.) Goal F addressed the desire for no waste to be disposed of, and for the minimal amount of waste generated to be either used or reused. It was acknowledged that in today's "throw-away" society this was an ambitious goal, and that legislation alone would not ensure its achievement. People's behavior would have to change, manufacturing processes would have to be overhauled, and products and packaging would have to be redesigned. RCW 82.08.0282, which exempts the sale of returnable containers for beverages and food from retail sales tax, and RCW 82.12.0276, which exempts the use of returnable containers for beverages and food from a use tax, were identified as useful provisions to help achieve this goal. In reality, little has changed in Washington in the last ten years.

According to "*Tax Shift – How to Help the Economy, Improve the Environment, and Get the Tax Man off Our Backs,"* by Alan Thein Durning and Yoram Bauman, Washington State taxes businesses' gross receipts, with special tax rules favoring mining, logging and other high resource impact activities. Washington's tax rate for service industries is three times the rate for manufacturers, and Washington has the most regressive tax system in North America.

Only a limited number of market development strategies are available in Washington State due to case law interpretation of the lending of credit prohibition provision in the State's constitution. Additionally, most market development strategies have been directed at the promotion of economic development in distressed areas, not at the promotion of recycling. To qualify for most of the existing programs in the State, a recycling business has to demonstrate economic development benefits. Market development tools include tax credits that target growing manufacturing, computer service or R&D companies in distressed areas, deferrals of sales tax on capital investments by manufacturing, computer service or R&D companies, and federal Industrial Development Bonds tax exempt bond financing that is limited to manufacturing and processing facilities.[5]

The *Washington State "Future of Recycling" Study* documented a substantial decline in the funding base for State action on recycling. Funding sources that were dedicated to this purpose were allowed to sunset and competition for remaining funds has increased. With no legislative action in the future, funds could be severely reduced for recycling programs at the state level,[6] making achieving our recycling goals and a more sustainable economy that much more difficult.

Local Level

At the local level there are few opportunities in tax policy, but that need not stop local governments from implementing "tax shifts" of their own. Washington cities have the ability to tax parking lots, and Washington counties may, with voter approval, put slim taxes on gasoline. Since Washington law is ambiguous about how cities can tax businesses, cities could tax businesses based on their pollution emissions, their solid waste bill or their number of parking spaces.[7] Still, while some of these actions are theoretically possible, they are politically very difficult to actually put into place.

Local jurisdictions face an unstable funding base that undermines the effectiveness of their recycling programs. This is particularly acute for counties that rely on the solid waste tipping fee as the primary mechanism to fund their activities. Most counties, encompassing the vast majority of Washington's population, do rely on tip fees as the primary revenue source for their solid waste programs and activities.

Proposed Alternatives[8]

Some economists have proposed "shifting" the tax burden from "goods" to "bads." The general belief behind tax shift proposals is that taxes should be used to influence the conservation of natural resources, and that "bads" – actions and uses that deplete natural resources – should be taxed (resource taxes), not "goods" – labor, profits, investments and capital. By taxing resource use, market economies can better recognize environmental costs. To tell a "good" tax from a "bad" tax with respect to the environment, it is helpful to consider whether the tax encourages or discourages resource conservation and pollution prevention, and whether the tax helps the market better reflect environmental costs, such as pollution's effects on human health.

Current labor and capital taxes include payroll taxes, personal income taxes, corporate income and other business taxes, and sales and property taxes. Property taxes that fall on the land portion would be considered a "resource tax." The gas tax would also be considered a "resource tax." Other "resource taxes" include health-oriented taxes on alcohol and tobacco, small energy taxes, pollution taxes and motor vehicle fees.

An example of taxing "goods" is the income tax that to some extent discourages additional work and increases the cost of labor to businesses. As a result, the income tax tends to encourage businesses to focus on conserving labor rather than on conserving resources.

Proponents of a tax shift argue that it would provide a least-cost approach to reducing pollution, congestion, waste and the long-term threat of climate change.[9] Proposed new taxes generally fall into four categories:

- Taxes on energy consumption, of which taxes on emissions of carbon dioxide and on gasoline are the most prominent
- Taxes on pollutants
- Taxes on virgin materials
- Higher user fees for the use of public resources

Also, shifting the tax system is designed to be revenue- and distributionally-neutral -- i.e., current taxes on "goods" would be reduced to offset the new revenue from taxes on "bads." This would help maintain a separation between decisions about how to spend public tax dollars from decisions about methods used to raise the revenue.

In "A Conceptual Framework to Compare Environmental Tax Shift Policies, Working Paper Series on Environmental Tax Shifting," by Don Fullerton, Redefining Progress, June 1998, the author describes the current emission or technology restrictions as "command and control instruments," that might sometimes be necessary for political or administrative reasons. But he argues that "incentive instruments" such as taxes, subsidies or permits can replace these command and control instruments, and pollution problems addressed by taxes on pollution or subsidies to abatement. Permits could be handed out to existing firms in proportion to past emissions or sold at auction by the government. Furthermore, he cites that much of the environmental economics literature finds that the use of incentives is more cost-effective than command and control restrictions.[10]

When considering a policy, we must consider whether it is a revenue raiser or not. In "A Conceptual Framework to Compare Environmental Tax Shift Policies, Working Paper Series on Environmental Tax Shifting," the following criteria are identified for evaluating potential policies:

- Economic efficiency
- Administrative efficiency
- Monitoring and enforcement capability
- Information requirements and the effects of uncertainty
- Political and ethical considerations
- Effects on prices that might shift the distribution among cohorts or demographic groups
- Taxes
- Imperfect competition
- Trade barriers
- Flexibility in the regulations to deal with transitions

Adopting a new approach to our tax and subsidy system will result in a new allocation of resources – both financial and environmental.

Potential Approaches

"*Welfare for Waste*" suggests a four-stage process for eliminating subsidies for virgin materials and wasting resources:

1) Congress should cut the direct federal subsidies listed above

2) Federal, state and local agencies should investigate state and local subsidies and recommend reforms to save taxpayer money while promoting materials efficiency

3) Congress and the executive branch should examine indirect federal subsidies, such as those for energy and transportation, and others that negatively affect materials efficiency, and identify opportunities for future cuts

4) Government should sponsor a public review to determine policies to develop a materials-efficient economy that requires less taxpayer subsidies

In *"Tax Shift,"* the authors propose the use of carbon taxes and pollution taxes. Carbon taxes would tax fuels in proportion to the carbon dioxide they emit; similar taxes on other greenhouse gases could also be used. Pollution taxes could include taxes on "point sources" of pollution. Current environmental regulations provide ready-made tools for taxing point sources. Managers of point sources must already monitor and report their emissions of many pollutants, and most governments in the NW already levy small fees based on these reports. Gradually increasing the pollution taxes until they approximate the true costs of the polluting would add economic teeth to the regulatory approach of pollution control agencies. Pollution taxes could be levied on the following:

- Point sources
- Motor Vehicle
- Farm Chemicals
- Pollution permits (like EPA's program for sulfur dioxide emissions allowance permits that allows for trading of those permits)
- Land-value taxes
- Environmental taxes

Other ideas for taxes on "bads" include:

- Water use taxes
- Hydropower use taxes
- Timber use taxes
- Fish and Game use taxes
- Mineral use taxes
- Resource windfall taxes
- Resource consumption taxes - taxing the extraction of natural resources tells everyone to conserve them, encouraging recycling, efficiency and frugality
- Traffic congestion taxes

While taxes are powerful tools, they have their limitations. First, there must be something to tax. This can be challenging in cases where it's impossible to measure what one wants to tax or where measuring is expensive or intrusive. Second, taxes cannot clean up existing messes. In these cases, regulations and other strategies are still necessary. It is important to examine our current tax structure because it provides insight to factors affecting our current solid waste management decisions.

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