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November 1995 • NREL/TP-430-8129

Integrated Solid Waste Management of Seattle, Washington

National Renewable Energy Laboratory
1617 Cole Boulevard
Golden, Colorado 80401

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A national laboratory of the U.S. Department of Energy
Managed by the Midwest Research Institute
for the U.S. Department of Energy
Under Contract No. DE-AC36-83CH10093

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NREL technical monitor: Philip Shepherd

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Abstract

The subject document reports the results of an in-depth investigation of the fiscal year 1992 cost of the City of Seattle, Washington, integrated municipal solid waste management (IMSWM) system, the energy consumed to operate the system, and the environmental performance requirements for each of the system's waste-processing and disposal facilities.

Actual data from records kept by participants is reported in this document. Every effort was made to minimize the use of assumptions, and no attempt is made to interpret the data reported. Analytical approaches are documented so that interested analysts may perform manipulation or further analysis of the data. As such, the report is a reference document for MSW management professionals who are interested in the actual costs and energy consumption for a one-year period, of an operating IMSWM systems.

The report is organized into two main parts. The first part represents the Executive Summary and Case Study portion of the report. The Executive Summary provides a basic description of the study area and selected economic and energy information. Within the Case Study are detailed descriptions of each component operating during the study period; the quantities of solid waste collected, processed and marketed within the study boundaries, the cost of managing municipal solid waste in Sevierville; an energy usage analysis; and finally a review of federal, state and local environmental requirement compliance; a reference section and a glossary of terms.

The second part of the report focuses on a more detailed discourse on the above topics.
In addition, the methodology used to determine the economic costs and energy consumption of the system components is found in the second portion of this report. The methodology created for this project will be helpful for those professionals who wish to break out the costs of their own integrated systems.

Other reports in the series include a Synopsis of Results and Methodologies which presents the principal findings from the case studies and case studies of the each of the six IMSWM systems evaluated in this program. In addition to the City of Seattle, Washington, the following systems participated in the evaluation: Minneapolis/Hennepin County, Minnesota; Palm Beach County, Florida; Scottsdale, Arizona; Sevierville, Tennessee; and Springfield, Massachusetts.

Key Words

Case Study
Co-Composting
Cost Analysis
Energy Analysis
Energy Recovery
Environmental Requirements: solid waste management
Integrated Municipal Solid Waste Management
Landfilling
Materials Recovery
Mixed Municipal Solid Waste Composting
Municipal Solid Waste
Recycling
Resource Recovery
Sevierville, Tennessee
Solid Waste
SWANA

Foreword

This case study report is one of six developed for the following integrated municipal solid waste management systems:

- Minneapolis (Hennepin County), Minnesota; NREL/TP430-20473
- Palm Beach County, Florida; NREL/TP430-8131
- Scottsdale, Arizona; NREL/TP430-7977
- Seattle, Washington; NREL/TP430-8129
- Sevierville, Tennessee; NREL/TP430-8136
- Springfield, Massachusetts; NREL/TP430-8137

All the reports, including a summary report (NREL/TP430-20471), are available through the National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, Colorado, 80401, or call (303)275-4363.

The authors are extremely grateful for the support and cooperation of the six systems managers and participants in those six systems. Without their assistance, this effort would not have been possible.

Funding for the conduct of the case studies and the development of the six reports was provided by the American Plastics Council and the United States Department of Energy's National Renewable Energy Laboratory.

In conducting the studies, the authors experienced considerable difficulty in gathering economic and energy information. In municipal solid waste management, no standard accounting methods exist. Further, local governments by tradition and practice maintain their financial records in a variety of ways to serve their own specific needs. The lack of a standard accounting procedure in the United States, and of standard definitions of solid waste, made the collection and analysis of the economic data a challenge. The methods for developing the cost information for this effort will be helpful to those with responsibilities for planning and implementing integrated municipal solid waste management systems. Also, the six sets of cost data will be useful for guiding other systems managers in their planning, cost accounting, and measuring of performance.

The development of the energy information represents a major step forward in analyzing integrated municipal solid waste management systems. The information in the six studies and the analytical methodology will be extremely useful to integrated municipal solid waste management systems planners, decision makers, and managers in the future.

Finally, as might be expected, the environmental regulatory information is limited. Although landfill and combustion facilities are under well-defined regulations, other portions of integrated municipal solid waste systems are not. The end result of these limitations is that the information presented on conformance with environmental requirements is sketchy for systems that do not include combustion.

A final caution to the readers of these reports is to not attempt to try to compare one system against the other. The authors **deliberately** did not do so for the very sound reason that it is ill-advised to attempt to compare systems that:

- are geographically different,
- are politically different,
- are structurally different in providing municipal solid waste services,

- are at different stages of development, and
- face different regulatory requirements.

Rather, readers of these reports are encouraged to examine and analyze (using the techniques and analytical methods of the six studies) their own geographical, political, structure, stage of development, and regulatory status and then assess those findings against six other sets of data to see how they can best make the best decisions for their systems.

Acknowledgments

SWANA is especially grateful for the assistance and support of many individuals and organizations who contributed information for this Seattle Case Study. From the City of Seattle: Nancy Glaser, Director, Seattle Solid Waste Utility; and several staff members, especially Nick Pealy, Jennifer Bagby, Steven Viney, Ray Hoffman, Ginny Stevenson, Aaron Ostrom, and Theresa Hill. In addition, individuals from several private firms in the area: William Harbert and Scott Carpenter, Waste Management of Seattle; Scott Fasser, Rabanco Recycling; Susan Bogert, Clean Washington Center; Jeffrey Morris, Sound Resource Management Group; and Suzanne Leger and Jon Allen, Cedar Grove Composting Facility.

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Executive Summary

Introduction

The following summary provides a review of the key findings of this case study. Readers are advised to read the *condensed* Seattle Cast Study, which follows this section, to fully understand how the economic, energy, and environmental results were developed. In addition, all data collected and analyzed during this study are available in the *detailed* Seattle Case Study in Appendices A through D.

Each integrated municipal solid waste management (IMSWM) system is unique due to geography, climate, customs, politics, and time. However, reader may benefit from the findings of this study *and* the study techniques and methodology to develop actual economic, energy, and environmental facts about their own IMSWM system. The cost information for each functional element of the IMSWM system allows readers to understand the significance of each element. Because each system is unique, readers are cautioned not to compare the findings of this particular study with their own system.

Background

Seattle, Washington ("the city"), is a medium-sized U.S. city with approximately 516,000 residents. In 1990, there were 249,032 households. Of these, 132,330 households single-family dwelling units, 113,146 households were in multifamily dwelling units (22,641 in buildings of two to four units, 71,285 in buildings of five to 49 units, and 19,220 in buildings with 50 or more units), and 3556 households were in mobile homes, trailers, and other dwellings.

During fiscal year (FY) 1992, about 542,000 tons of municipal solid waste (MSW) were generated in Seattle. The city manages the collection and disposal of this MSW through Seattle's Solid Waste Utility (SWU). Most services are provided through contractual agreements with private service providers.

The Solid Waste Utility

The SWU was established in 1961 as a division of the city's Department of Engineering. It has three primary functions:

(1) To provide direct services (transfer stations and long-haul transport) for the management of MSW

(2) To purchase services for the collection of recyclables, garbage, and yard waste; the processing of recyclables; and the disposal of MSW

(3) To manage an integrated solid waste management system, including program planning, administration, and evaluation; rate-setting; budgeting and finance; and community relations.

The SWU operates as an independent financial entity that must be self-supporting, i.e., it can receive no subsidies from general funds or tax revenues. Therefore, the SWU must charge fees to cover its costs. The fees that the SWU charges its customers are variable, based on volume.

SWU has the authority to control the disposition of residential and commercial MSW, exclusive of "materials destine for recycling," generated within the city's borders, pursuant to the 1991 Seattle waste flow control ordinance. MSW collection, processing, and disposal services for residential customers are provided through contracts between the SWU and private service providers. The SWU owns and operates

two transfer stations and maintains a fleet of transfer vehicles for transporting materials from the transfer stations to the local Union Pacific railhead. The MSW is rail hauled to an Oregon landfill; yard waste is transported to the Cedar Grove Composting Facility.

System Overview

The city's 1992 IMSWM system consisted of the following integrated system components:

- Separate collection of residential garbage, yard waste, and recyclables by private service providers under contract to the SWU
- Two transfer stations (North and South) owned and operated by the SWU
- A household hazardous waste (HHW) drop-off site located at the south transfer station
- Two privately owned and operated materials recovery facilities (MRFs)
- A privately owned and operated yard waste composting facility
- A rail yard, referred to as the railhead, for the intermodal transfer of sealed containers of MSW
- A privately owned and operated landfill, located in Oregon, for the disposal of garbage.

Definitions

MSW managed by the city is categorized in this report as garbage, bulky waste, yard waste, and recyclables. Household hazardous wastes (HHW) are also collected from residents who choose to haul it to the city's HHW drop-off site.

ANALYZED MSW—That portion of the total MSW stream for which the associated management net costs are known, or at a minimum, can be reasonably estimated. The reason for limiting the types of MSW included in Analyzed MSW is that only that portion of MSW should be included for which sufficient data were available to draw defensible conclusions regarding the allocation of cost to the tons of MSW managed.

GARBAGE—Garbage is all MSW exclusive of source-separated trash, recyclables, yard waste, household hazardous waste, and bulky waste.

BULKY WASTE—Oversized items, including white goods and furniture, that have been separated from the MSW stream for separate collection.

YARD WASTE—Vegetative material that is segregated from the MSW stream for separate collection and/or processing, including grass, prunings, plants, and small tree limbs, but excluding tree stumps, land-clearing debris, and other large vegetative matter.

PROGRAM INCREMENTAL COSTS (OR SAVINGS)—Determined for MSW management components (or programs) of each IMSWM system by calculating the system cost of MSW management, first with the inclusion of a specific program, and then calculating the cost of MSW management without that program. Landfilling (as it is practiced in each case study) is considered the basic program that is not

optional. Therefore, the Program Incremental Cost is the difference between the cost of managing MSW with the inclusion of a particular program and the cost of managing MSW without that program.

RECYCLABLES—Materials that still have useful physical or chemical properties after serving their usefulness for a given individual or firm, and can, therefore, be reused or recycled for the same or other purposes.

Key Findings

Discussion of costs

Of the 541,400 tons of MSW managed within the city, 232,000 tons were analyzed ("Analyzed MSW") to determine the cost of Seattle's IMSWM System. Because the collection costs for 309,000 tons of self-hauled MSW are not known, this tonnage is excluded from the analysis, as is the tonnage of C&D waste (which is not considered MSW). The cost of MSW management in Seattle as reported in the study includes collection, transfer, haul, processing, composing, disposal, and the marketing of recovered materials for the 232,000 tons.

Overall Program Costs

The total FY 1992 cost for the SWU to manage 232,000 tons of Analyzed MSW was about $30.2 million, or about $130 per ton. This total cost breaks down to, in rounded numbers:

Table ES-1. Cost of Program Elements

Category	Tonnage	Total Cost	Total Cost Per Ton
Garbage	142,000	$21.6 million	$152
Recyclables	54,600 (51,100 recycled)	4.5 million	88 (per ton recycled)
Yard Waste	34,790	4.1 million	119 (per ton sold)
TOTAL	**232,000**	**$30.2 million**	**$130**

The cost of managing the 798 tons of HHW processed in FY 1992, which was analyzed separately because collection costs are not known, was about $1.4 million, or more than $1,700 per ton, not including collection costs.

Collection and processing account for more than 50% of the total cost of the Seattle System, while transfer, haul (excluding rail haul), and disposal account for more than 30% of the cost. For recyclables and yard waste, collection/processing accounts for 70% or more of the costs to manage those components of the waste stream.

Program Incremental Costs

The incremental cost for each of the resource recovery programs, i.e., the cost (or savings) associated with adding the resource recovery program to the IMSWM system, is the difference between the cost of managing all the MSW with the inclusion of a particular program and the cost of managing all the MSW

without that program. The program incremental cost (or savings) is, therefore, a measure of the impact of any particular program on the cost of managing all MSW.

The FY 1992 program incremental cost (or savings) of each of the city's resource recovery programs was, in rounded numbers:

Table ES-2. Incremental Cost of Program Elements

Program	Tonnage	Incremental Cost (Savings)	
		Dollars	$ Per Ton
Curbside Recycling	48,200	($17,200)	—
Yard Waste Composting	45,500	$568,000	$13

In addition to the incremental cost or savings that can be attributed to each of the resource recovery programs, each of them contributes materials to the economy and reduces the use of available landfill space.

Energy Usage Analysis

These case studies were intended to analyze energy used in MSW management. However, available data were limited; energy usage results presented for Seattle relate to the data that were available, *not* to the entire system.

The primary forms of energy used within Seattle's IMSWM system are transportation fuels (gasoline and diesel fuel) for collection, haul, and facility vehicles, and electricity consumed internally by solid waste processing or disposal facilities. The only energy produced within the system is methane gas generated at the Columbia Ridge Landfill in Oregon. However, the gas is flared and, therefore, is not used as a productive energy resource.

Data on energy consumption for the Seattle IMSWM system were available only on the Recycle America Materials Recovery Facility. Analysis of that data indicated that, on a basis of equivalent gallons of diesel fuel per ton, the energy consumption association with the curbside recycling program in FY 1992 was:

Activity	Gal/Ton
Collection of recyclables	3.6
Processing of recyclables	0.3
Total	3.9

Data on energy used in other aspects of integrated MSW management were available (and were analyzed) in several other case studies in this series. Energy consumed or saved in the use of recovered materials to make other products is not included in this analysis because it is outside the IMSWM boundary. However, because many manufacturing processes that use recovered materials use less energy than virgin material processes (especially aluminum recycling), this exclusion may understate the overall energy efficiency of recycling. This series of case studies did not attempt to consider all aspects of the life cycle of products that may wind up in the MSW stream; other studies may take these aspects into consideration.

Environmental Regulatory Framework

Environmental regulations for the elements of an IMSWM system are directed primarily at the facilities that serve such a system. For the most part, these facilities will be one or more of the following:

- Transfer station
- Materials recovery facility
- Compost facility
- Waste-to-energy facility
- Sanitary landfill.

In the state of Washington, the authority for regulating solid waste management and protecting against negative environmental consequences of such management activities is granted within the Washington Solid Waste Management Law, Revised Code of Washington, Title 70, Chapter 95 (RCW 70.95), passed initially in 1969 (the "Solid Waste Management Law"). The Washington Department of Ecology (WDOE) is responsible for developing regulations pursuant to state legislation.

The Solid Waste Management Law established the following priorities for solid waste collection, handling, and management, in the order listed: (1) waste reduction, (2) recycling, with source separation of recyclable materials as the preferred method, and (3) energy recovery, incineration, or landfilling of mixed wastes. In addition, a state goal of 50% recycling by 1995 was set. The primary focus of the Solid Waste Management Law is on the development, maintenance, and content of county and city comprehensive solid waste management plans. The law requires the environmental permitting of all facilities by local health departments and grants authority to the WDOE to develop minimum permitting requirements for the protection of public health and the environment. In general, the requirements related to recycling operations are less stringent than the General Requirements for Solid Waste Handling Facilities.

In accordance with Washington Law, the two transfer stations, the Cedar Grove composting facility, the two materials recovery facilities, and the Household hazardous Waste Collection facility housed adjacent to the South Transfer Station are required to obtain permits from the local health department. All facilities are managed in accordance with their respective permit requirements. The landfill, located in Oregon, is required to meet the Oregon Solid Waste Regulations.

Introduction

Seattle, Washington ("the city"), is a medium-sized city with approximately 516,000 residents. In 1990, there were 249,032 households, of which 132,330 households were in single-family dwelling units, 113,146 households were in multifamily dwelling units (22,641 in buildings of two to four units, 71,285 in buildings of five to 49 units; and 19,220 in buildings with 50 or more units), and 3556 households were in mobile homes, trailers, and other dwellings.

Seattle is the largest metropolis in the northwestern United States and is the seat of King County, Washington. The mainstay of the region's economy has long been the aircraft industry. Shipbuilding and wood products manufacturing are the other major industries in Seattle. In addition, the city has long been a major port for trade to Asia and the principal gateway to Alaska.

The city is located on a narrow, hilly isthmus between Puget Sound on the west and Lake Washington on the east. It lies between two major mountain ranges: the Cascades to the east and the Olympics to the west. Although the city receives an average of only 35 inches of precipitation annually, there is measurable rainfall on an average of 150 days per year.

During fiscal year 1992, about 542,000 tons of municipal solid waste (MSW) were generated in Seattle. The city manages the collection and disposal of this MSW through Seattle's Solid Waste Utility (SWU).

The City's Integrated MSW Management System

The Solid Waste Utility

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The SWU operates as an independent financial entity that must be self-supporting, i.e., it can receive no subsidies from general funds or tax revenues. Therefore, the SWU must charge fees to cover its costs. The fees that SWU charges its customers are variable, or volume-based, rates.

The SWU has the authority to control the disposition of residential and commercial MSW, exclusive of "materials destine for recycling," generated within the city's borders, pursuant to the 1991 Seattle flow control ordinance. MSW collection, processing, and disposal services to residential customers are provided through contracts between the SWU and private haulers. However, the SWU owns and operates two transfer stations and maintains a hauling fleet for transport of materials from the transfer stations to the local Union Pacific railhead for rail hauling to an Oregon landfill, and yard waste to the Cedar Grove Composting Facility.

System Overview

The city's 1992 Integrated Municipal Solid Waste Management (IMSWM) System consisted of the following integrated system components:

- Separate collection of residential garbage, yard waste, and recyclables by private firms under contract to the SWU
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- A rail yard, referred to as the railhead, for the intermodal transfer of sealed containers of MSW
- A landfill, located in Oregon, for the disposal of garbage.

The locations of the facilities that constitute the city's IMSWM system are shown in Figures 1 and 2.

MSW managed by the city is categorized in this report as garbage, bulky waste, yard waste, and recyclables. HHW is also collected from residents who choose to haul it to the city's HHW drop-off site.

A description of each of the individual components of the city's IMSWM system follows.

System Component Descriptions

Collection

Residential garbage is collected by two local firms that separately service northern and southern sectors of the city under contract to the SWU. General Disposal provides weekly garbage collection to the northern sector of the city, while U.S. Disposal, a subsidiary of Rabanco, provides weekly garbage collection for the southern sector of the city (see Figure 3). Both companies began 7-year contracts with the SWU in January 1989. Under these contracts, customers were offered a choice between curbside/alley collection and backyard collection, and given a 40% rate-reduction incentive for choosing curbside/alley collection.

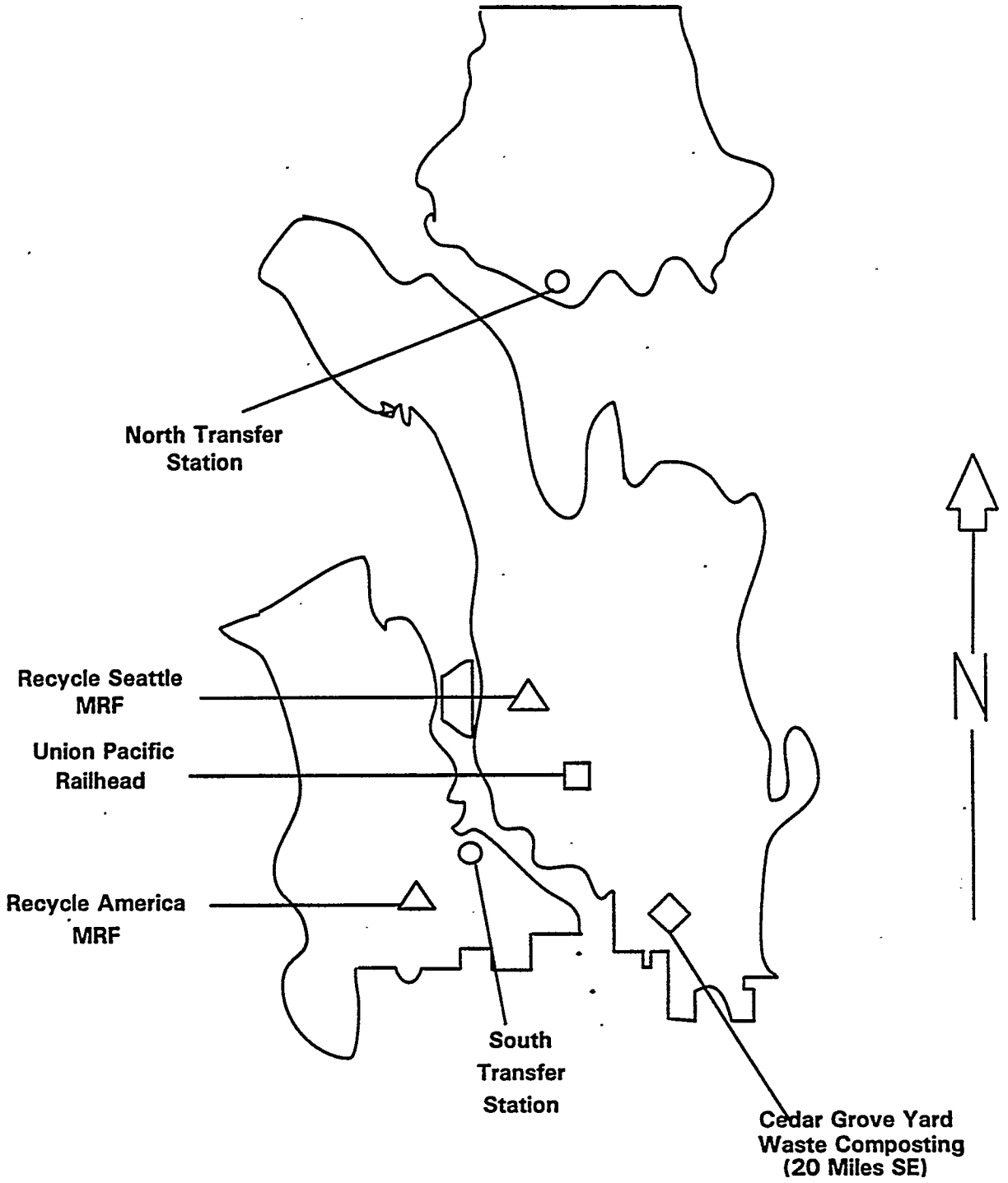


Figure 1. Location of Seattle IMSWM system facilities

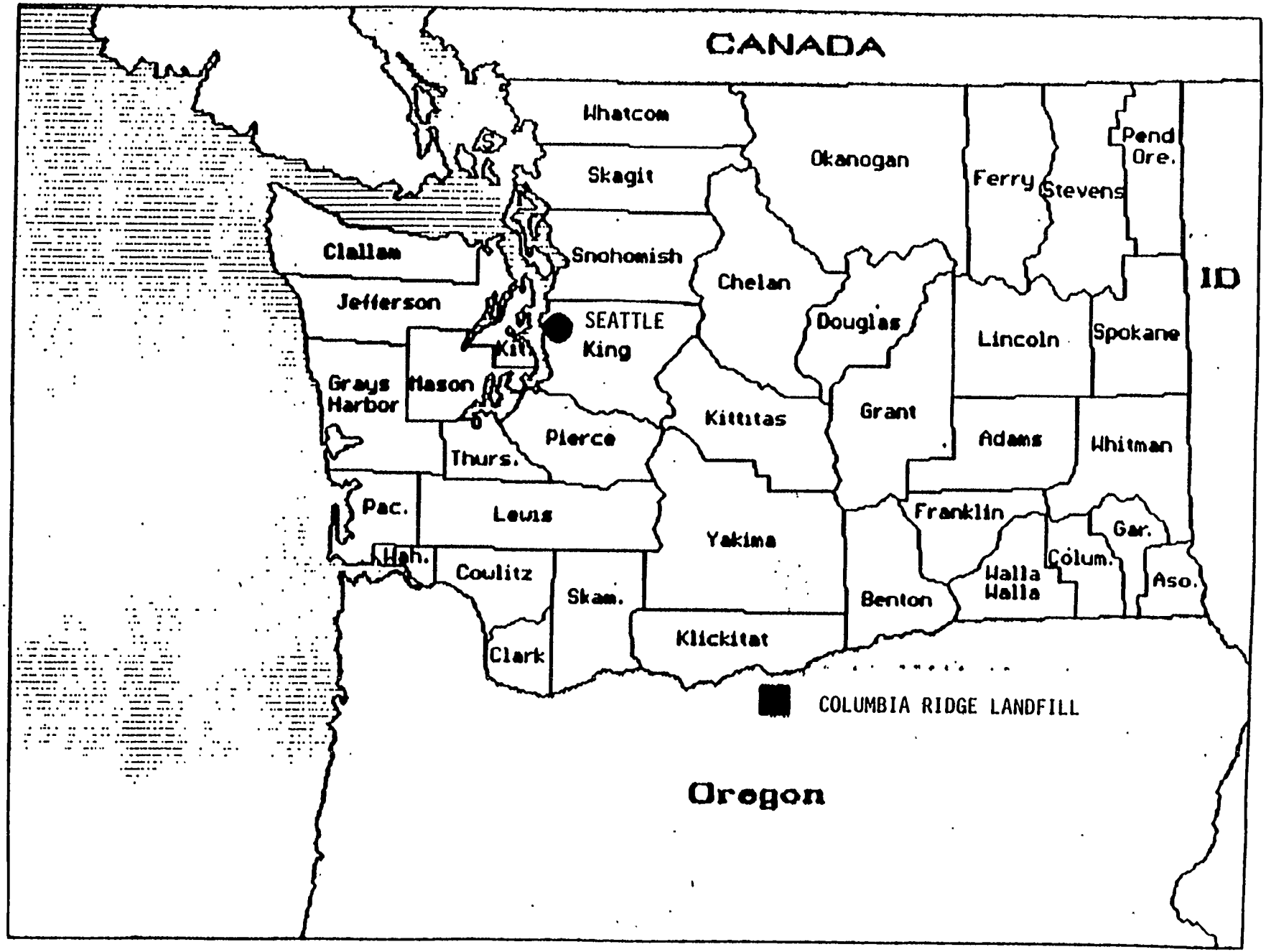


Figure 1. Columbia Ridge Landfill location

FIGURE 3: SEATTLE'S NORTHERN AND SOUTHERN SECTORS AS DESIGNATED FOR YARD WASTE COLLECTION

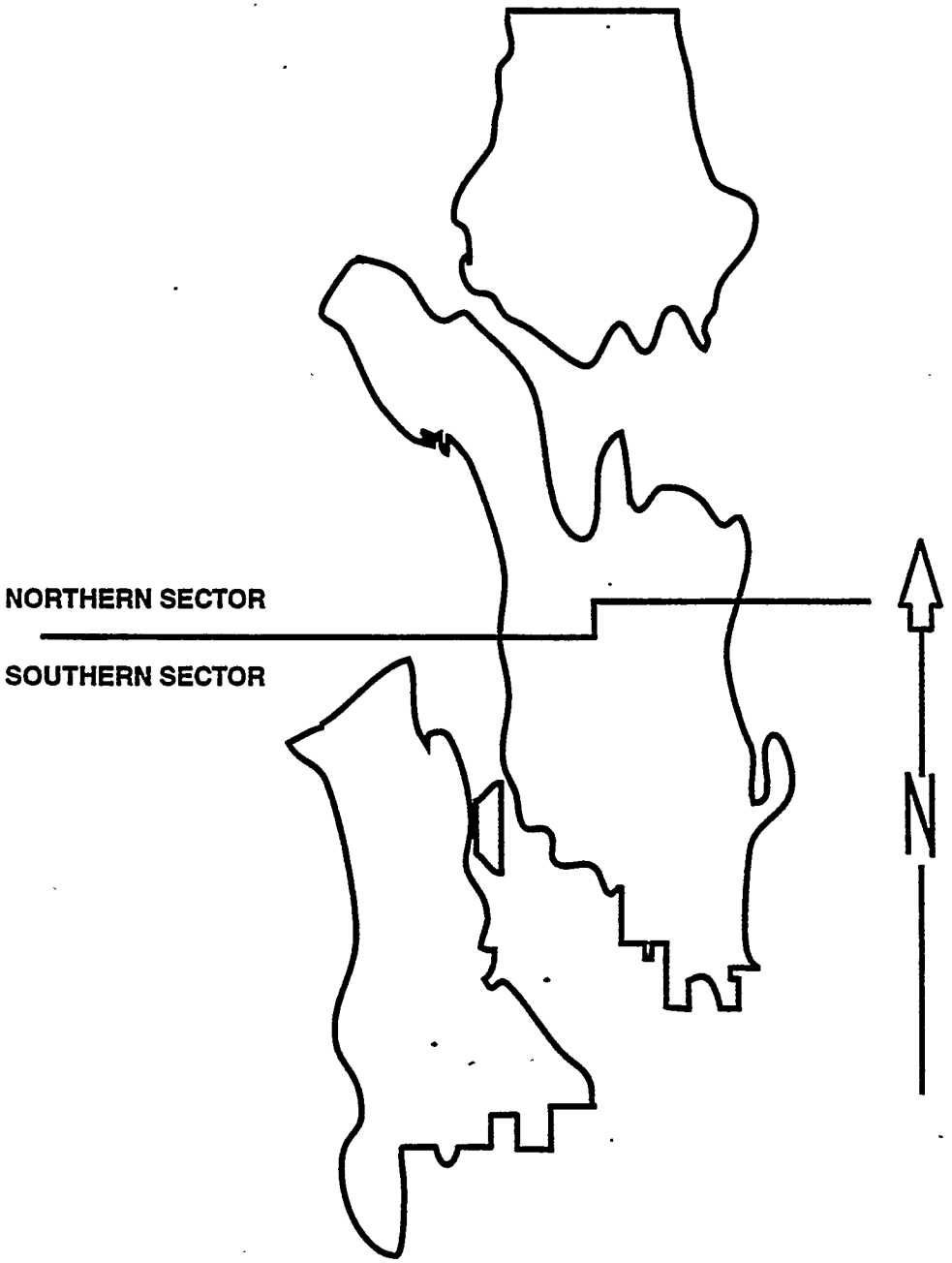


Figure 3. Seattle's Northern and Southern Sectors as designated for yard waste collection

General Disposal uses side-loading trucks with one-person crews for most of its collection. U.S. Disposal uses rear-loading trucks with two-person crews. Collection is provided weekly to customers, with the exception of apartment buildings. Because apartments may require multiple collections, one collection is provided on the usual collection day for the area in which the building is located, and additional collections are made by an assigned apartment crew (usually one person) on other days. A few apartment building receive Saturday service. All collected residential garbage is delivered to one of two city-owned transfer stations.

Yard waste is also collected by General Disposal in the northern sector of the city and by U.S. Disposal in the southern sector. General Disposal collects yard waste every week on the same day it collects garbage. U.S. Disposal collects yard waste on a biweekly basis from March through September and on a monthly basis from November through February. U.S. Disposal also collects yard waste on the same day it collects garbage. Both firms use 20-cubic-yard rear-loading packer trucks. U.S. Disposal delivers its collected yard waste either to the Rabanco transfer facility or directly to the Cedar Grove composting facility, where it is processed. General Disposal delivers its collected yard waste to the city's South Transfer Station. The city then transfers this yard waste to 40-foot trailers and transports it to the Cedar Grove composting facility.

Residential recyclables are collected (from single family through four-plex households) and processed by two separate firms under contract to the SWU for separate northern and southern sectors of the city (see Figure 4). The northern sector is serviced by Recycle America, a subsidiary of Waste Management Industries (WMI), while the southern sector is serviced by Recycle Seattle, a Rabanco subsidiary. Recyclable materials collected include glass bottles and jars, newsprint, aluminum cans, tin cans, mixed paper, polyethylene terephthalate (PET) and translucent and opaque high density polyethylene (HDPE) plastic containers.

Recycle America collects source-separated recyclables placed into the three 14-gallon, stackable bins it provides to each participating resident. Residents put newspaper into one bin; mixed paper into a second bin; and glass, tin, aluminum, PET, and white and clear HDPE plastics into the third bin. Collection is performed weekly. Collection is accomplished using large-capacity, automated, top-loading trucks. The collected recyclables are delivered to the Recycle America's MRF, depicted in Figure 5, located in south Seattle. In 1992, 64,000 of 70,000 eligible households signed up for service in the northern sector recycling program.

Recycle Seattle collects commingled recyclables placed into the one 90-gallon cart it provides to each participating resident. Recycle Seattle uses packer trucks, modified to include compartments behind the cab for source-separated glass. Collected recyclables, which include the same materials collected by Recycle America, are delivered by Recycle Seattle to the Rabanco MRF, depicted in Figure 6, which is also located in south Seattle. In 1992, 64,600 of 78,500 eligible households signed up for service in the southern sector recycling program.

In addition to curbside recyclables collection, more than 40 privately owned buy-back and drop-off facilities are located in Seattle. Residents are free either to drop off their recyclables, generally to facilities run by charities, or to be paid for delivering their recycling to privately run buy-back centers.

FIGURE 4: SEATTLE'S NORTHERN AND SOUTHERN SECTORS AS DESIGNATED FOR RECYCLABLES COLLECTION

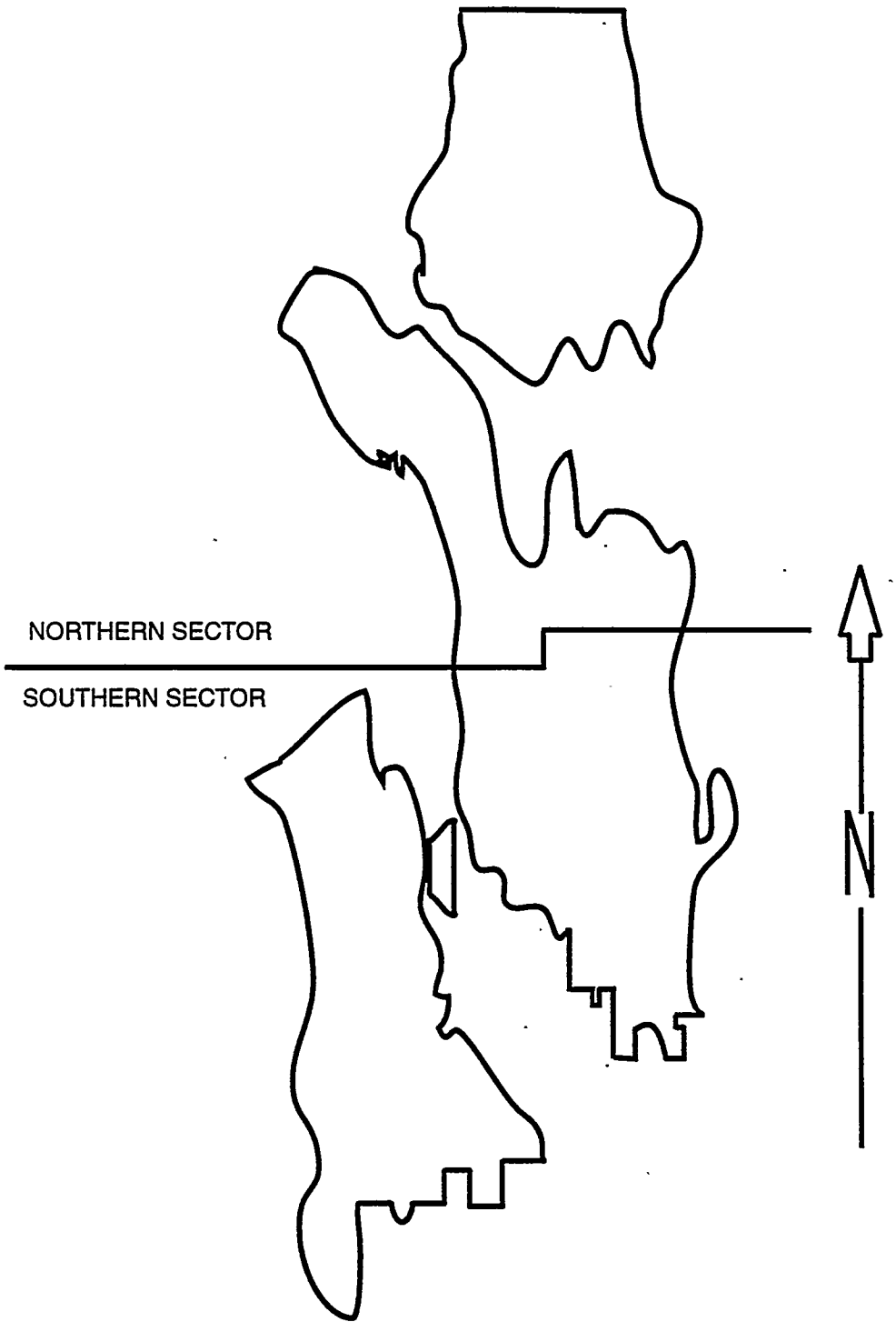
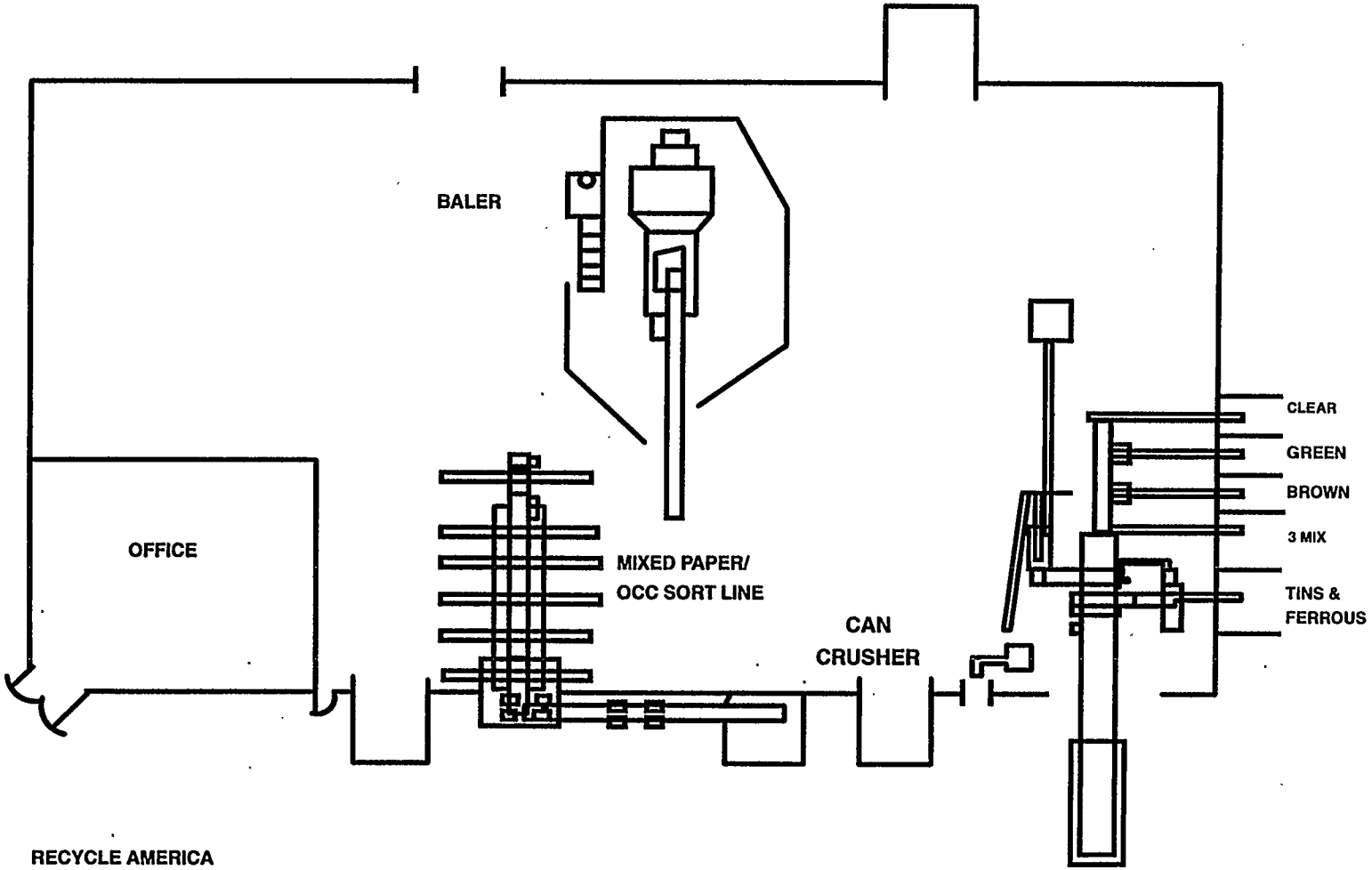


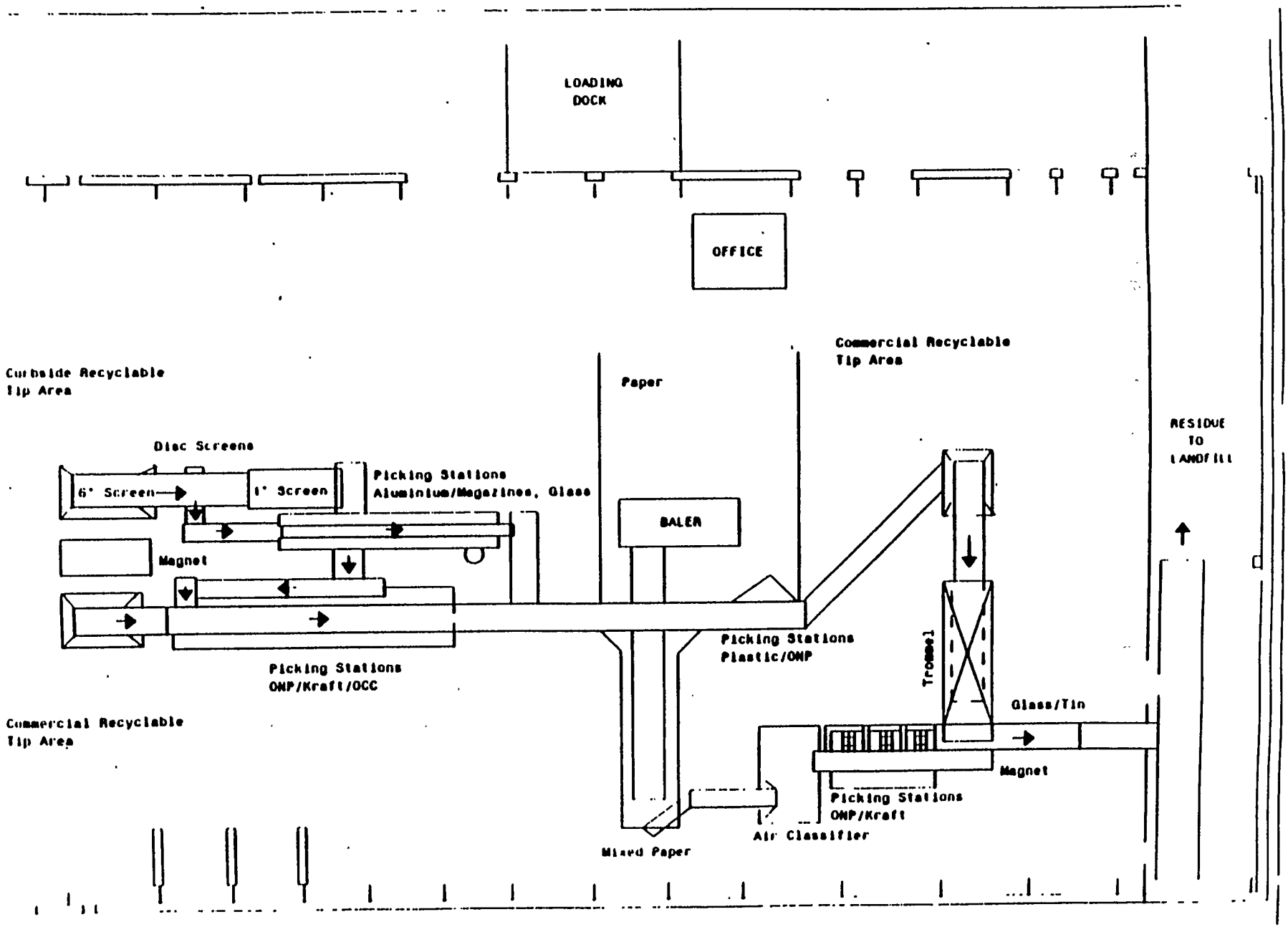
FIGURE 5
RECYCLE AMERICA MRF



RECYCLE AMERICA
WASTE MANAGEMENT, INC.
SEATTLE, WASHINGTON

NOT TO SCALE

FIGURE 6: RECYCLE SEATTLE (RABANCO) MRF



Transfer Stations

Residential garbage collected by General Disposal and U.S. Disposal is taken to one of two transfer stations owned and operated by the city—the North Transfer Station or the South Transfer Station. The South Transfer Station also accepts yard waste collected by General Disposal, which is then transported by the city to the Cedar Grove composting facility in 40-foot trailers. HW is collected at the South Transfer Station (through residential drop-off) and disposed of separately. Each transfer station has a design capacity of 1000 tons per day and measures 28,800 square feet.

Residential garbage accounts for approximately two-thirds of the MSW handled at the transfer stations. Wastes that are self-hauled by city residents account for less than 10% of the waste handled at the transfer stations. Waste self-hauled by commercial businesses and delivered by haulers who collect from commercial customers accounts for 28% of the waste handled at the stations.

Solid waste is delivered to the transfer stations compacted, in 25- to 28-ton loads, into 40-foot, waterproof, sealed shipping containers mounted on trailer chassis. The shipping containers are then taken to the railhead for transport to the Oregon landfill.

In addition to the two city-owned transfer stations, two privately owned transfer facilities that handle primarily commercial wastes are also located in Seattle.

Materials Recovery and Recycling

The Rabanco Recycling Center is an 80,000-square-foot commingled recyclables processing facility designed to process 500 to 700 tons per day of recyclables, including clean paper, newspaper, cardboard, plastics, paper-rich commercial loads, and commingled recyclables from curbside collection programs. The center uses a combination of conveyors, trommels, disc screens, magnetic separation, air classification, hand picking, and bailing to recover and process recyclable materials.

The Recycle America Processing Center is a 43,000-square-foot facility that processes source-separated recyclables collected from Recycle America's curbside program. Collected materials include newspaper, cardboard, mixed paper, tin, glass, aluminum, and plastic. Because recyclables are collected in compartmentalized trucks, the facility is primarily used for hand-sorting and bailing and has a capacity of 400 tons per day. Sorting of glass, tin, and aluminum is done through a combination of magnets and hand-sorting.

Yard Waste Processing and Composting

In 1988, a city ordinance mandated that yard waste be separated from garbage. The city began a three-part program consisting of (1) backyard composting, for which customers received free in-home instruction on composting techniques and a free composting bin, (2) curbside yard waste collection, whereby as many as 20 cans, bags, or bundles of yard waste are collected for a small monthly fee by the contractors collecting regular household garbage, and (3) expansion of the transfer station "Clean Green" collection program, whereby yard waste can be self-hauled to the two city transfer stations.

All yard waste collected through curbside collection and the Clean Green transfer station programs is processed at the Cedar Grove Composting Facility, located in Maple Valley, Washington, approximately 20 miles southeast of Seattle in rural King County. This facility is owned and operated by the Cedar Grove Compost Company, a subsidiary of Northern Environmental Industries. Yard waste collected by U.S. Disposal is either taken directly to the Rabanco transfer station, from where it is hauled to Cedar

Grove, or directly hauled to Cedar Grove. Yard waste collected by General Disposal is delivered to the South Transfer Station, where it is then transferred by the city to the Cedar Grove facility.

The Cedar Grove facility has a capacity of approximately 100,000 tons per year. Cedar Grove accepts Seattle's yard waste as well as that of other nearby communities and commercial self-haulers. Materials delivered to the composting facility ar visually inspected, screened, and shredded. Yard waste is placed in windrows and is then cured. The compost product is screened to remove plastic residue, rocks, and wood fragments.

Rail Haul and Landfilling

While a significant portion of Seattle's MSW stream is recovered through recycling, reuse, and composting, the balance still requires disposal. In 1990, a 30-year contract between the SWU and Washington Waste Systems was put into place, and rail hauling to, and disposal at, Washington Waste System's Columbia Ridge Landfill (in Gilliam County, Oregon) began in 1991.

The SWU and private haulers deliver containerized waste to the Union Pacific railhead in Seattle. Private haulers must pay a tip fee for waste delivered to the railhead. At the railhead, each container is weighed, and container information is entered into a computerized manifest and container tracking system. The waste is then loaded onto the train, which is composed of approximately 50 railcars, carry 100 "piggybacked" containers. Washington Waste Systems provides all railcars, shipping containers, intermodal lift equipment, and landfill equipment. The SWU and private transfer station operators provide their own compactors, tractors, and chassis to haul containers from transfer stations to the railyard.

The loaded train leaves Seattle three evenings a week and travels 300 miles to the Columbia Ridge Landfill, where it arrives early in the morning. Washington Waste Systems personnel unload the containers and place them on truck chassis to be delivered to the landfill face. Hydraulic tippers tilt the chassis and containers to dump the waste, which is then immediately spread and compacted. It is covered each day with 6 inches of compacted dirt.

The landfill includes a composite liner system and leachate collection system. A monitoring system, including gas monitoring probes, groundwater monitoring wells, and vadose zone monitoring, is also in place.

Household Hazardous Waste

A permanent HHW waste collection facility is housed within the city's South Transfer Station site. Types of HHW collected include latex paint, solvent-based paint, paint-related wastes (e.g., thinners, stains and varnishes, solvents, pesticides, and corrosives (acids and bases, mainly found in cleaning products and miscellaneous chemicals). The facility is open Thursday through Sunday year-round.

The HHW facility is constructed as a drive-through site using prefabricated storage containers on a concrete slab. The majority of the materials collected at the HHW facility are brought to one of two final destinations. Materials with remaining energy value are used as an alternative fuel for a federally permitted cement kiln in Kansas. Pesticides, poisons, and other materials without energy value are disposed of in a hazardous waste landfill in Oregon.

Both of the city's transfer stations accept used motor oil, also a type of HHW. The SWU has also placed collection tanks for used oil at many area auto supply stores. The SWU provides the tanks, contracts with a hauler for collection of the oil, and arranges for disposal of contaminated oil.

Other Waste Management Programs

Backyard Composting

During late 1989 and early 1990, Seattle stepped up its efforts to encourage backyard composting by distributing compost bins to 6000 city residents. By 1992, many more than 25,000 bins had been distributed. The composting bins used now, called the "Seattle Composter," come in two sizes: 21 cubic feet and 12 cubic feet. They are made of recycled HDPE collected from Seattle's eight plastics drop-off sites.

MSW and Other Waste Collected, Processed, and Disposed of in Seattle

A total of approximately 542,000 tons of MSW and other waste material was processed or disposed of by the SWU in FY 1992. Of this amount, about 80.2% was garbage, 8.5% was yard waste, and 10.4% was recyclables. The remaining 0.9% consisted of white goods, HHW, and wood wastes. Table 1 summarizes the tonnage collected, processed, and disposed of by the SWU in FY 1992. This tonnage does not include recyclables that are segregated from the MSW stream for recycling by commercial and business establishments. Therefore, the data in this table do not provide a complete account of recycling activities in Seattle. A waste flow and resource recovery diagram of the waste stream processed through the SWU's IMSWM system is depicted in Figure 7.

Garbage and Yard Waste Collection and Transfer

In FY 1992, General Disposal collected 96,679 tons of garbage and 24,547 tons of yard waste from the northern sector of the city, while U.S. Disposal collected 45,475 tons of garbage and 10,243 tons of yard waste from the southern sector.

Both of these contractors were also responsible for the collection of bulky waste within their respective service areas. Collection of bulky waste is performed on a "call in" basis. The SWU reported that about 3340 tons of white goods were collected by the two collection companies together in FY 1992.

Similarly, an estimated 11,129 tons of self-hauled yard waste was delivered to the transfer stations by commercial landscapers and residents as part of Seattle's Clean Green program.

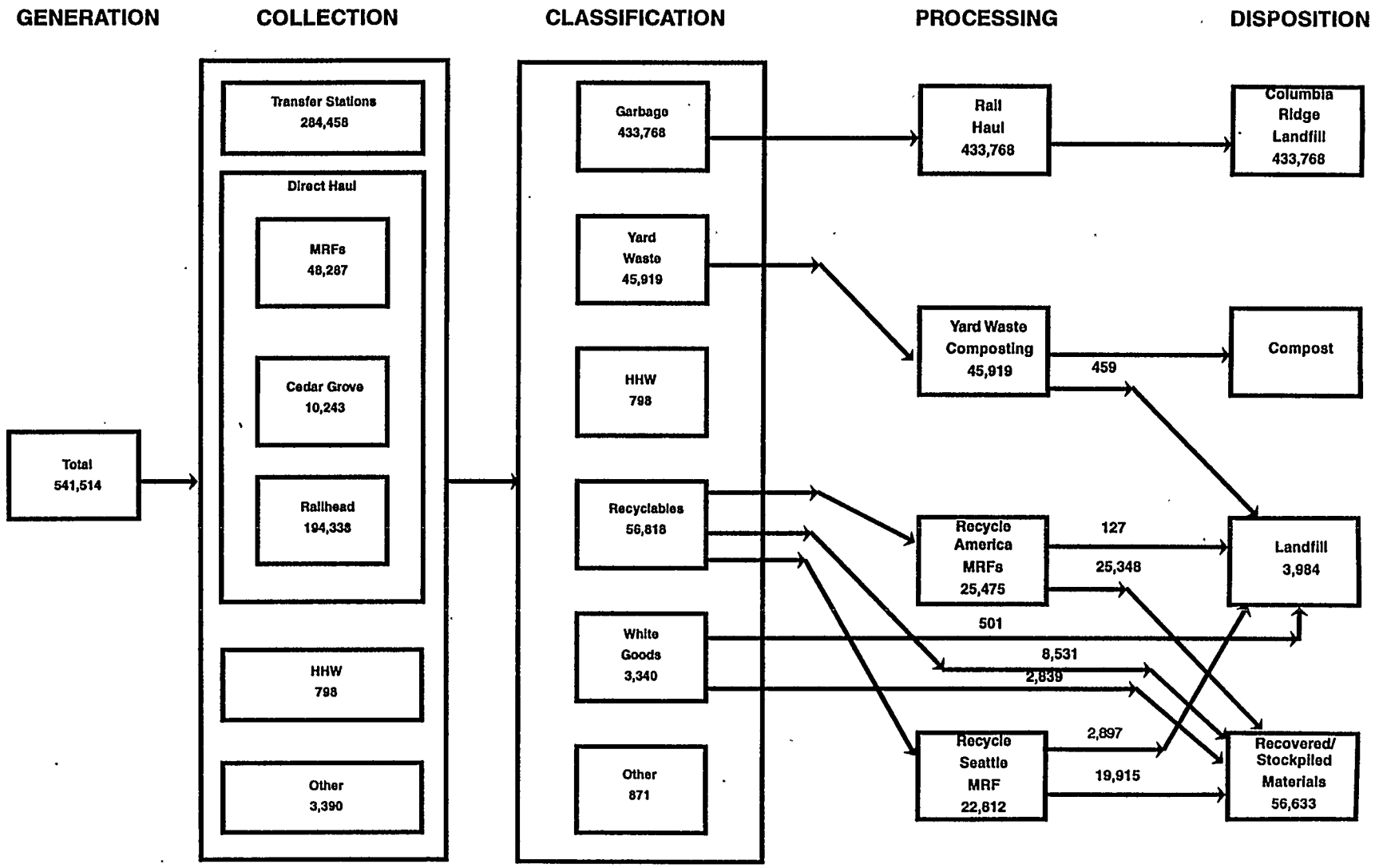
A total of 433,768 tons of garbage and 45,919 tons of yard waste were collected in Seattle and processed through or disposed of in the SWU's IMSWM system. Of this amount, 275,106 tons, or about 57%, were transferred through the two city transfer stations.

Table 1. MSW and Other Wastes Collected, Processed, and/or Disposed of in Seattle in FY 1992

Waste Type	Percent	Tons
MSW		
Garbage		
General Disposal	17.9	96,679
U.S. Disposal	8.4	45,475
Self Haul to Transfer Station	18.0	97,276
Self Haul to Railhead	35.9	194,338
Subtotal Garbage	80.2	433,768
Yard Waste		
General Disposal	4.5	24,547
U.S. Disposal	1.9	10,243
Self Haul to Transfer Station	2.1	11,129
Subtotal Yard Waste	8.5	45,919
Recyclables		
Recycle America	4.7	25,475
Recycle Seattle	4.2	22,812
Apartment Recycling	0.5	2,973
Self Haul to Transfer Stations	0.9	5,141
Other (e.g., plastic drop-off)	0.1	417
Subtotal Recyclables	10.4	56,818
White Goods	0.6	3,340
Household Hazardous Waste	0.1	798
Other Wastes	0.2	871
Totals	100.0	541,514

Note: This table does not include recyclables that are segregated from the MSW stream for recycling by commercial and business establishments. Therefore, the data in this table do not provide a complete account of recycling activities in Seattle. The SWU reports that an additional 195,300 tons of recyclables were collected through private activities. (SWU "Summary of Recycling Program Impacts," April 21, 1989)

FIGURE 7: WASTE FLOW AND RESOURCE RECOVERY DIAGRAM
SEATTLE, WASHINGTON (FY92)



White goods, wood waste, and self-hauled recyclables were also processed through the transfer stations, resulting in a total of about 284,000 tons of waste, exclusive of HHW, being handled at the city's transfer stations in FY 1992. Thus, approximately 53% of the 541,514 tons of waste that were processed through or disposed of in the SWU's IMSWM System went through the city's transfer stations. The balance, about 257,000 tons of waste, was direct hauled to various facilities, including the Utility's HHW drop-off facility, the Union Pacific Railhead, the Cedar Grove composting facility, the Recycle America MRF, or the Recycle Seattle (Rabanco) MRF.

Recyclables Collection and Processing

During FT 1992, Recycle America and Recycle Seattle collected 25,475 and 22,812 tons of recyclables respectively. The recyclables collected on behalf of the SWU were delivered to and processed at each firm's MRF. Neither MRF is dedicated exclusively to processing these curbside-collected recyclables. The balance of 8531 tons of recyclables was collected as part of the SWU's apartment recycling and drop-off center programs, including the drop off-program at each city transfer station.

Estimates of the composition of the materials collected in the north and south sectors, as provided in Figure 8, were made by the SWU.

Yard Waste Composting

In FY 1992, 45,919 tons of yard waste were delivered by or on behalf of the SWU to the Cedar Grove composting facility. About 78% of this tonnage was hauled to Cedar Grove by the SWU from its transfer stations. The balance was either delivered directly by U.S. Disposal or transferred through Rabanco's transfer station, which is located adjacent to Recycle Seattle's MRF.

Household Hazardous Waste

A reported 798 tons of HHW was collected, processed, and disposed of by the Utility in FY 1992. Of this amount, 543 tons, or 68%, were waste oil.

Rail Haul and Landfilling

Washington Waste Systems, Inc., rail hauled 433,768 tons of garbage to the Columbia Ridge Landfill for disposal in FY 1992. Of this amount, 194,338 tons, or about 45%, were delivered directly to the railhead by sources other than the SWU.

Markets for Recovered Materials

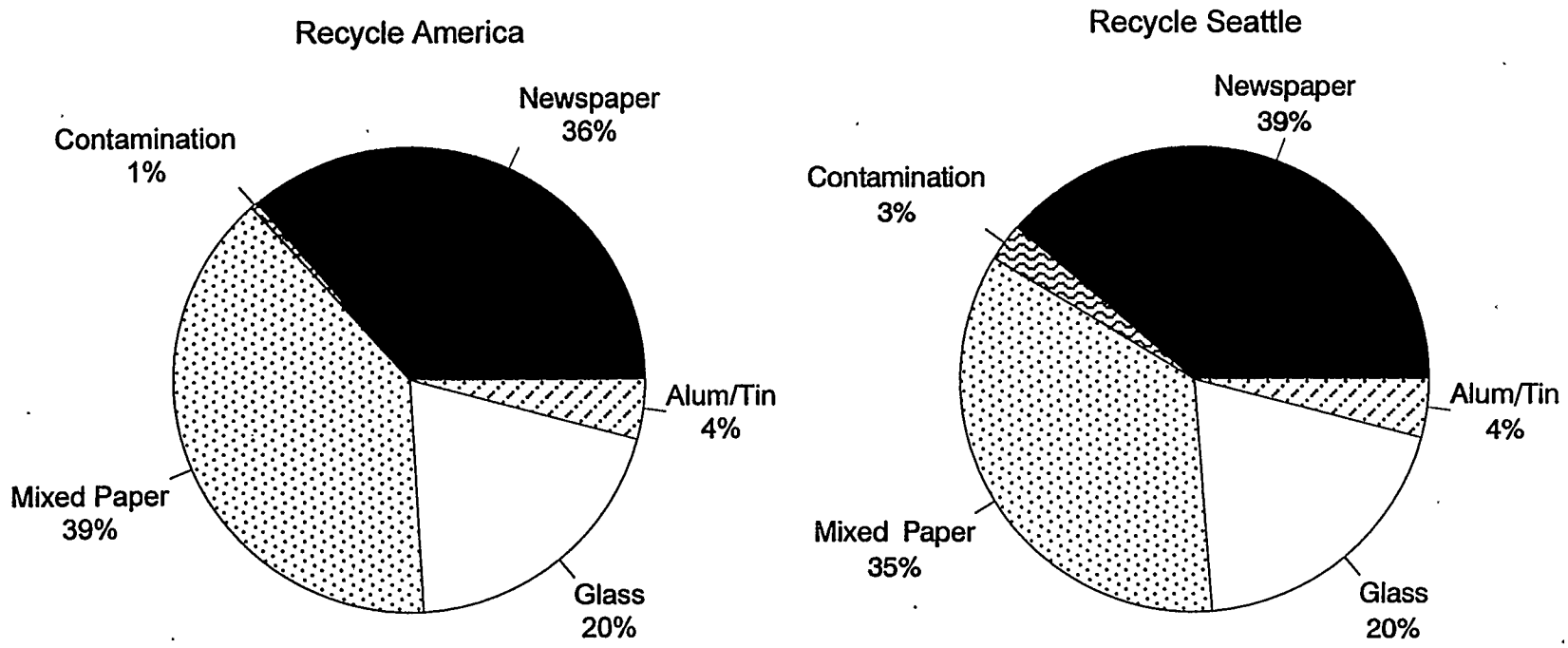
There are strong local markets for several recovered materials in Seattle. Within the city, there is a major detinning plant, a scrap steel mill, and a large glass container manufacturer. Three pulp mills in the state are adding de-inking capacity for newsprint. Aluminum generally was shipped to smelters in the southeastern United States, while mixed paper and some plastics were shipped from the Port of Seattle to Pacific Rim markets. In general, the market for recovered plastics was weak in FY 1992.

About 54,180 tons of recovered recyclable materials were sold to various outlets during FY 1992. Table 2 summarizes the markets for each of the recovered materials sold.

The recovered tin cans were marketed to Proler International. The cans were transported via trailer truck o Proler's detinning facility in Seattle.

FIGURE 8: ESTIMATED MATERIALS COLLECTED IN FY 1992

North and South Sectors
(Percent by Weight)



Source: "Seattle's Curbside Recycling Program," Road to Recovery, page 3.

Cost of MSW Management in Seattle

The cost of MSW management in Seattle includes collection, transfer, haul, processing, composting, disposal, and the marketing of recovered materials.

Summary of Results

Of the approximately 541,400 tons of MSW managed within the city, about 232,000 tons were analyzed (Analyzed MSW) to determine the cost of Seattle's IMSWM system. Because the collection costs for the approximately 309,000 tons of self-hauled MSW are not known, this tonnage is excluded from the analysis, as is the tonnage of C&D waste (which is not considered MSW).

Overall Program Cost

The total FY 1992 cost for the SWU to manage the approximately 232,000 tons of Analyzed MSW was about $30.2 million, or about $130 per ton.

Table 2. Markets for Selected Recovered Materials Sold in FY 1992

Recovered Materials	Tonnage	Tons Rejected	Distance to Vendor (miles)	Mode of Transport	Remanufacture Reuse	Comments
Aluminum	635	None	20	Transfer Trailer	Can Sheet	Markets to local smelters
Subtotal	635					
Glass						
Aggregate	4,533	None	3	Transfer Trailer	Bottles/Jars	
Green				Recycle America: Transfer Trailer (6-9 tons) Roll-Off Containers Recycle Seattle: Transfer Trailer (10-12 tons) End Dump		
Subtotal	4,533					
Paper						
Corrugated	190	None	485	Transfer Trailer (23 tons)	Corrugated Medium	Also processes mixed paper, clippings
	62	None	320	Transfer Trailer (> 23 tons)	Linerboard	
Mixed	29	None	Pacific Rim-Indonesia, China, Taiwan	Shipped via Bales In Containers	Boxboard	
	1,854					
	610		India, China	Transfer Trailer (21 metric tons)	Boxboard	
News #8	4,291	Low %	205	Transfer Trailer (23 tons)	Newsprint	
	3,515		195			
		None	70	Transfer Trailer (30 tons)	Telephone Directory Stock	
Paper Phone Books						
Subtotal	10,551					
Plastics						
HDPE	172	None	Pacific Rim	Transfer Trailer (20 tons)	Pellets added to Virgin Materials	
Plastic PET	21	None	Pacific Rim	Transfer Trailer (20 tons)	Gas Cans, Toys, Low Level Plastics	
Subtotal	193					
Tin Cans	997			Transfer Trailer (20 tons)		Detinning facility
Subtotal	997					
TOTAL	16,909					

This total cost breaks down to, in rounded numbers:

Category	Tonnage	Total Cost	Total Cost per ton
Garbage	142,000	$21.6 million	$152
Recyclables	54,600 (51,100 recycled)	4.5 million	$ 88 (per ton recycled)
Yard Waste	34,790 (34,440 sold)	4.1 million	$119 (per ton sold)
Total Average	**232,000**	**$30.2 million**	**$130**

The cost of managing the 798 tons of HHW processed in FY 1992, which was analyzed separately because collection costs are not known, was about $1.4 million, or more than $1,700 per ton.

As shown in Figure 9, collection and processing account for more than 50% of the total cost of the Seattle System, while transfer, haul (including rail haul), and disposal account for more than 30% of the cost. Figure 10 shows the allocation of costs to each of the key functional areas (e.g., collection/processing, transfer, and haul) for each of the program areas. Note that for recyclables and yard waste, collection/processing accounts for 70% or more of the costs to manage those components of the waste stream.

Program Incremental Costs[1]

The incremental cost for each of the resource recovery programs, i.e., the cost (or savings) associated with adding the program to the IMSWM System, is the difference between the cost of managing all the MSW with and without that program. The Program Incremental Cost (or Savings) is, therefore, an appropriate measure of the impact of any particular program on the cost of managing MSW. The FY 1992 Program Incremental Cost (or Savings) of each of the city's resource recovery programs was, in rounded numbers:

Program	Tonnage	Incremental Cost (Savings)	
		Dollars	$ Per Ton
Curbside Recycling	48,200	($17,200)	—
Yard Waste Composting	45,500	$568,000	$13

In addition to the incremental cost or savings that can be attributed to each of the resource recovery programs, each of them contributes materials to the economy and reduces the use of available landfill space. These attributes are shown in Table 3.

[1]The complete final report contains analyses of marginal costs and marginal costs of substitution in addition to the incremental cost analyses

FIGURE 9: LOCATION OF TOTAL COSTS FOR IMSWM SYSTEM IN FY92

Allocation by Functional Area
(Cost to Manage 232,000 tons of Analyzed MSW)

TOTAL COST IS $30,230,000

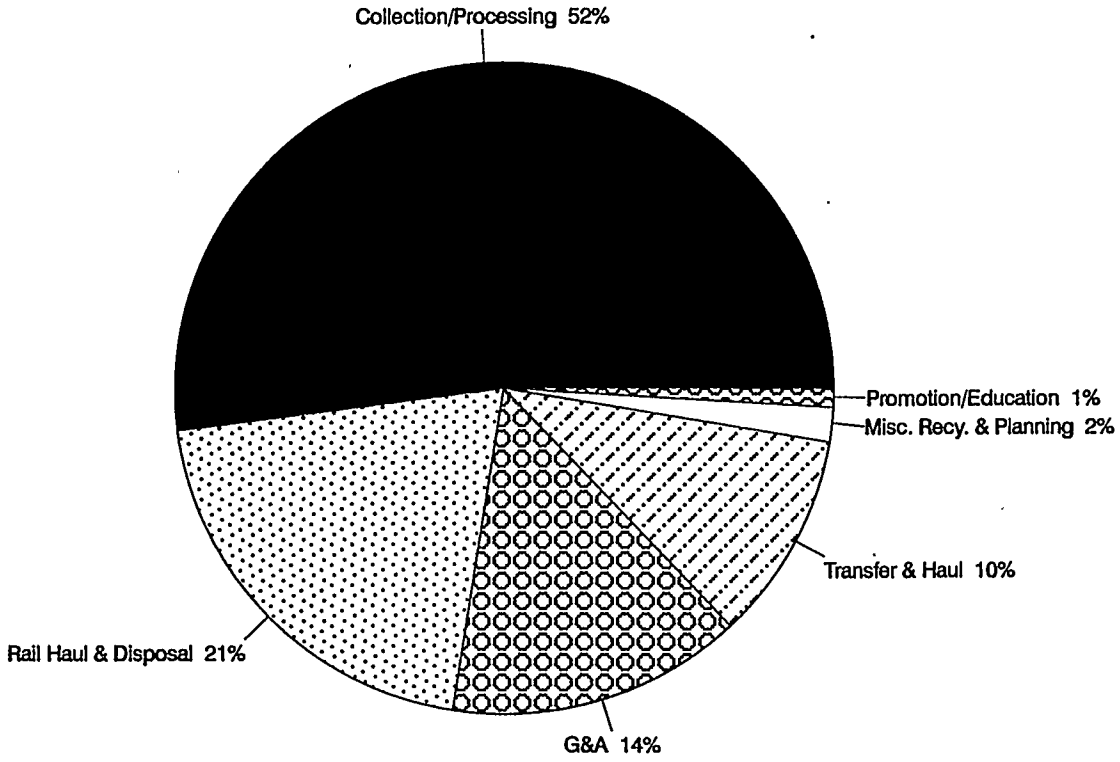
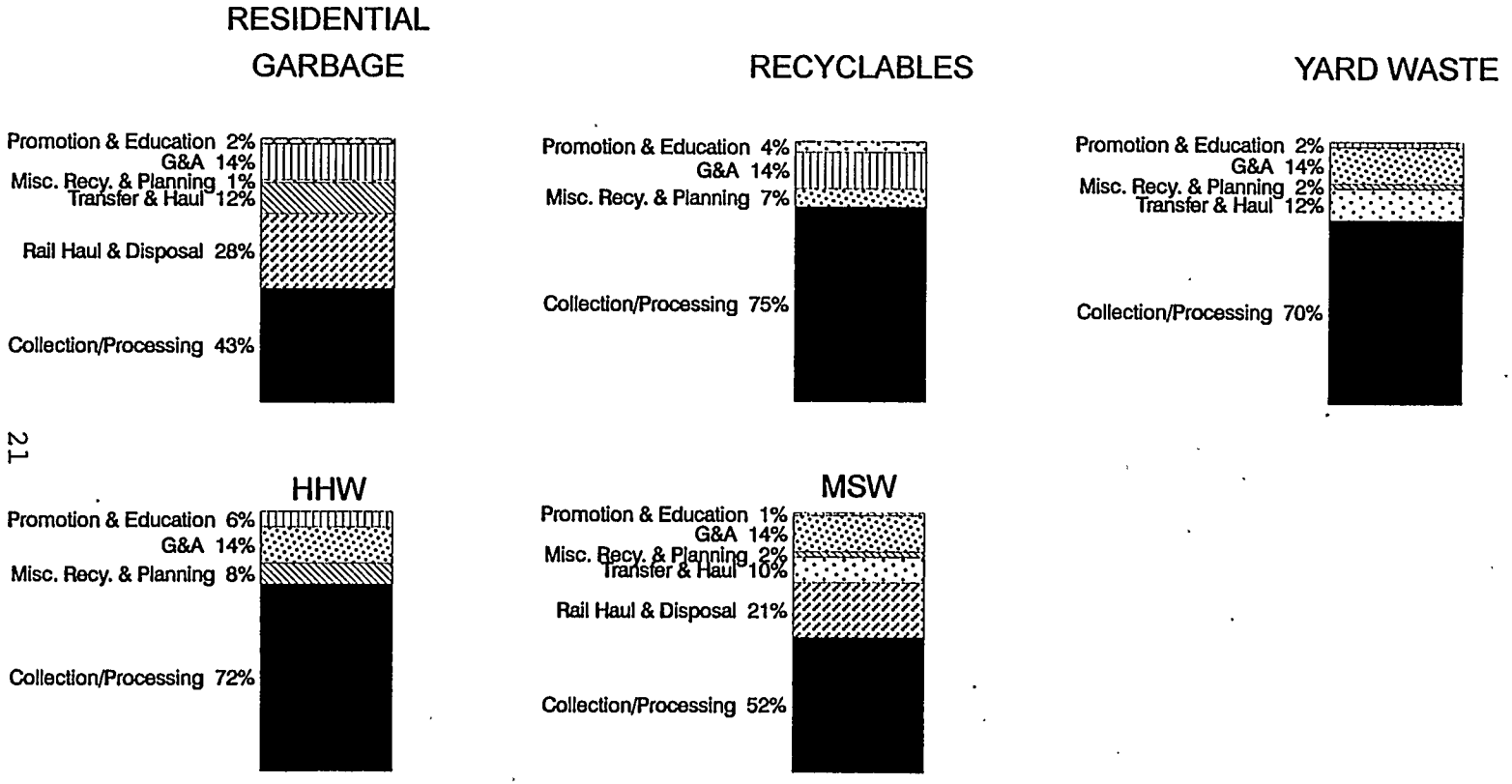


FIGURE 10: ALLOCATION OF COSTS TO MANAGE MSW IN SEATTLE, WA

Allocation by Functional Area



Energy Usage Analysis

The primary forms of energy used within Seattle's IMSWM System are transportation fuels (gasoline and diesel fuel) for collection, haul, and facility vehicles, and electricity consumed internally by solid waste processing or disposal facilities. The only energy produced within the system is methane gas generated at the Columbia Ridge Landfill. However, the gas is flared and, therefore, is not used as a productive energy resource.

Data on energy consumption for the Seattle IMSWM System was available only on the Recycle America Materials Recovery Facility. Analysis of that data indicated that, on a basis of equivalent gallons of diesel fuel per ton, the energy consumption associated with the curbside recycling program in FY 1992 was:

Activity	Gal/Ton
Collection of recyclables	3.6
Processing of recyclables	0.3
Total	**3.9**

Environmental Regulations and Permit Requirements

The costs of compliance with the environmental regulations and permit requirements discussed in this section are reflected in the costs and energy consumption levels reported in this case study.

Overview of Federal Legislation and Regulations

The potential environmental impacts of solid waste management facilities have led to the development of an extensive network of federal and state regulations. Embodied in many federal environmental laws is an implicit federal-state partnership whereby the federal government sets the agenda and standards for pollution abatement while the states carry out the day-to-day activities of implementation and enforcement.

The Clean Air Act, most recently amended in 1990, established programs for protecting public health and the environment from exposure to gaseous emissions including toxic air pollutants. The Clean Water Act, most recently amended in 1987, is the principal federal law protecting the nation's waterways from pollution. The Safe Drinking Water Act, most recently amended in 1988, established programs for protecting public drinking water systems from harmful contaminants. The Solid Waste Disposal Act and Resource Conservation and Recovery Act (RCRA) of 1976, most recently amended in 1992 and currently undergoing Congressional review for reauthorization, is the main piece of federal legislation addressing landfill disposal regulation.

Because Seattle's IMSWM system does not include MSW combustion, the Clean Air Act did not apply to the facilities comprising the system.

Table 3. Incremental Cost and Effectiveness of Resource Recovery Programs in Seattle, Washington (FY 1992)

Resource Recovery Program	Tons Managed	Total Incremental Cost	Average Incremental Cost	Effectiveness	
				Materials Recovered	Landfill Volume Reduction
Curbside Recycling	48,236	($17,200)	($0)/Ton ($0)/Cubic Yard	9,200 Tons Newspaper	44,300 Cubic Yards
				19,100 Tons Mixed Paper	43,800 Cubic Yards
				7,860 Tons of Glass	10 ,000 Cubic Yards
				2,100 Tons Metal/Plastic	5,260 Cubic Yards
				48,200 Total	103,000 Cubic Yards
Yard Waste Composting	45,460	$568,000	$13/Ton $3/Cubic Yards	28,800 Tons Compost	209,000 Cubic Yards

Pursuant to the Clean Water Act, a solid waste management facility cannot cause a discharge of pollutants that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) into United States waters. The states are responsible for establishing water quality standards and are authorized to issue discharge permits. The NPDES permit requires the source to attain technology-based effluent limits, "best practicable control technology" (BPT), and "best available technology" (BAT). The initial BPT limitations focus on regulating discharges of convential pollutants such as bacteria and oxygen-consuming materials. The BAT limitations emphasize controlling toxic pollutants such as heavy metals, pesticides, and other organic chemicals. Table 4 provides a listing of the pollutants regulated under the NPDES.

A separate permit is required to dispose of dredge or fill material into the waters, including wetlands. The U.S. Army Corps of Engineers administers this permit program. Other regulations promulgated under the Clean Water Act include guidelines for using and is posing of sewage sludge.

Pursuant to the Safe Drinking Water Act, a facility or practice cannot contaminate an underground drinking water source beyond the solid waste management facility boundary or beyond an alternate boundary. Table 5 provides the maximum contaminant levels as promulgated under this act. The primary enforcement responsibility lies with the states, provided they adopt regulations as stringent as the federal requirements, develop adequate procedures for enforcement, maintain records, and create plans providing emergency water supplies.

Pursuant to RCRA, criteria were established to determine which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment. The objective of these criteria is to mitigate adverse effects through the protection of floodplains, endangered species, surface water, and groundwater. These criteria also provide guidelines for sludge use and disposal under the Clean Water Act.

Subtitle D or RCRA primarily addresses nonhazardous waste, whereas Subtitle C of RCRA addresses hazardous waste disposal. In October 1991, the Environmental Protection Agency promulgated revised Subtitle D regulations applicable to municipal solid waste landfills, with an effective date October 1993. In general, the new regulations require liners, leachate collection, groundwater monitoring, and corrective action at municipal landfills.[2]

Overview of State Legislation, Regulations, and Permit Requirements

In the state of Washington, the authority for regulating solid waste management is granted within the Washington Solid Waste Management Law. The state environmental agency, the Washington Department of Ecology (WDOE), is responsible for developing regulations pursuant to state legislation. These regulations specify planning requirements, facility standards, and permitting requirements for all types of solid waste management facilities within the state.

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[2]On October 1, 1993, the federal criteria for MSW landfills under subtitle D or RCRA were amended to extend the date of compliance for small landfills to April 9, 1994. In addition, the MSW landfill criteria were amended by removing the exemption from the groundwater monitoring requirements and by delaying the date for compliance with all requirements of the MSW landfill criteria for 2 years for owners and operators of MSW landfill units in arid and remote areas that meet the qualifications of the small landfill exception in the MSW landfill criteria. "Solid Waste Disposal Facility Criteria; Delay of Compliance and Effective Dates," *Federal Register*, Vol. 58, No. 189 pp. 51536-51548, 1993.)

Table 4. Pollutants Regulated by the NPDES Permit Program

Oxygen Demand: Biochemical Oxygen Demand Chemical Oxygen Demand Total Oxygen Demands Total Organic Carbon Other	**Metals:** Aluminum Cobalt Iron Vanadium
Solids: Total suspended solids (Residues) Total dissolved solids (Residues) Other	**Metals (all forms):** Other metals not specifically listed above
Nutrients: Inorganic Phosphorus Compounds Inorganic Nitrogen Compounds	**Inorganic:** Cyanide Total Residual Chlorine
Detergents and Oils: MBAS NTA Oil and Grease Other Detergents or Algicides	**Minerals:** Calcium Chloride Fluoride Magnesium Sodium Potassium Sulfur Sulfate Total Alkalinity Total Hardness Other Minerals

Source: 40 CFR, EPA, Part 123—"Appendix A—Criteria for Reporting in the NPDES Programs."

Table 5. Maximum Contaminant Levels Promulgated under the Safe Drinking Water Act

Chemical	MCL (mg/l)
Arsenic	0.05
Barium	1.0
Benzene	0.005
Cadmium	0.01
Carbon Tetrachloride	0.005
Chromium (Hexavalent)	0.05
2,4-Dichlorophenoxy Acetic Acid	0.1
1,4-Dichlorobenzene	0.075
1,2-Dichloroethabe	0.005
1,1-Cichloroethylene	0.007
Endrin	0.0002
Fluoride	4.0
Lindane	0.004
Lead	0.05
Mercury	0.002
Methoxyclor	0.1
Nitrate	10.0
Selenium	0.01
Silver	0.05
Toxaphene	0.005
1,1,1-Trichloroethane	0.2
Trichloroethylene	0.005
2,4,5-Trichlorophenoxy Acetic Acid	0.01
Vinyl Chloride	0.002

Source: 40 CFR, EPA, Part 257—"Criteria for Classification of Solid Waste Disposal Facilities and Practices."

The Solid Waste Management Law established the following priorities for solid waste: (1) waste reduction, (2) recycling, with source separation of recyclable materials as the preferred method, and (3) energy recovery, incineration, or landfilling of mixed wastes. In addition, a state goal of 50% recycling by 1995 was set.

The primary focus of the Solid Waste Management Law is on the development, maintenance, and content of county and city comprehensive solid waste management plans. The law also grants authority to the WDOE to develop regulations for solid waste handling and facility siting, and to local boards of health to develop regulations for implementing management plans. The law requires the environmental permitting of all facilities by local health departments and grants authority to the WDOE to develop minimum permitting requirements for the protection of public health and the environment.

Overview of Local Regulations

In the city of Seattle, solid waste management activities are regulated by the Seattle-King County Department of Public Health (DPH). Regulations pertaining to solid waste management and the potential environmental impacts of those management activities are codified as the King County Solid Waste Regulations.

Within the King County regulations are provisions for the administration of solid waste management programs; the permitting of solid waste management facilities; fee structures for permitting and disposal; requirements for waste management practices, including general facility requirements; and requirements for specific processing or disposal facilities. For the most part, these regulations are modeled after the state requirements or respond directly to mandates issued within the state regulations to provide for sound solid waste management and protection of public health and the environment.

Facility Permitting Requirements

The state solid management regulations stipulate that all disposal sites and facilities must obtain a permit from the jurisdictional health department prior to operating. The state and local regulations are implemented through the requirements of the specific facility permits.

Seattle's North and South Transfer Stations

Seattle's North and South Transfer Stations were constructed in 1966 and 1968, respectively. At that time, environmental permitting requirements were minimal. However, during the last several years, as those requirements have increased in scope and stringency, the transfer stations have had to comply with new requirements to obtain annual operating permit renewals.

In accordance with current state and local regulations, these transfer stations must minimize visibility and access to the public and prevent public nuisances. the stations must be surrounded by fencing, trees, or other natural structures so as to be screened from view and blowing litter, and to control accessibility by the public as well as by rodents and other vectors. In addition, pollution control measures for the protection of surface and ground waters and air quality must be implemented, including odor and dust control.

In 1990, the SWU had begun implementing its plans to switch to rail haul. Consequently, in February 1990, the SWU submitted new plans for the operation of the North and South Transfer Stations. In 1992, subsequent to these changes in operation, the two transfer stations were granted minor discharge authorizations from METRO's Industrial Waste Section for the discharge of washdown water, leachate, and vehicle-washing discharge. The authorization allows for a maximum of 5000 gallons per day of discharge and contains limits for pH, temperature, fats, oils and greases, flammables, settleable solids, organic compounds, hydrogen sulfide, and 10 metals.

In FT 1992, the transfer stations were operated in conformance with these environmental requirements.

South Transfer Station Household Hazardous Waste Collection Facility

The city's HHW Collection Facility is housed adjacent to the South Transfer Station. Under state regulations, HHW is categorized as a moderate risk waste, which is a category of solid waste that exhibits properties of hazardous waste but is not regulated under the state's rules for dangerous waste. Facilities handling HHW must at a minimum meet the requirements of the Minimum Functional Standards for Solid Waste Handling Facilities.

The city's HHW collection facility is also characterized in statutory language as a waste recycling facility. Given the facility's designation, application for a permit from the jurisdictional health department was required, as was the filing of an environmental checklist, as required by the State Environmental Policy Act (SEPA).

The DPH received the permit application for the HHW Collection Facility in 1991. In addition to the solid waste recycling facility permit, approvals from the Shoreline Management Division, and Fire and METRO discharge permits, were also required to be obtained for the facility. The facility permit was issued in 1992.

Construction and operation of the facility were designed to comply with state and local regulations. However, in April 1992, A DPH site inspector observed numerous problems related primarily to the manner in which the wastes were piled up, the space between waste piles, and the high volume of backlogged waste. In addition, more than 100 barrels of unknown material were present at the site. As a result, in June 1992, the HHW Collection Facility wa issued a violation of City Ordinance by the Seattle Fire Department for these and other storage- and start-up-related problems.

In October 1992, the DPH requested that a long-range plan for dealing with unknown materials brought to the facility site be submitted. As part of the short-term solution of the storage of unknown, the facility closed for 2 weeks in late October and early November so that the backlog could be dealt with and the unknowns cleared out. Subsequently Burlington Environmental, Inc., was contracted with to test, sort, pack, and dispose of inadequate or non-labeled containers of HHW that had accumulated at the facility.

Cedar Grove Composting Facility

In addition to applying for the facility operating permit issued by the Department of Public Works, the Cedar Grove Composting Facility was also required to file a SEPA checklist, apply for a grading permit from the King County Building and Land Development Division, obtain a WDOE storm water permit, and register the facility and equipment with the Puget Sound Air Pollution Control Agency. The permit was formally issued in 1989. The Cedar Grove Composting Facility began operation in early 1989 following the receipt of its facility operating permit.

In accordance with general requirements, a plan of operation, a closure plan, and a postclosure plan were required to be developed for and adhered to by the composting facility. Local regulations for King County specify that all waste must be stored in a safe and sanitary manner, free of all noise, odor, or vector nuisances. All containers for solid waste storage must be rigid, durable, watertight, corrosion resistant, and vector proof. The permit for the composting facility also requires that compost leachate monitoring be performed on a monthly basis. In addition, the permit also includes requirements for the development and maintenance of a compost inventory control program. The permit stipulates that only the following materials are acceptable for composting at the facility: grass clippings, leaves, brush, prunings, nontreated wood waste, and clean dirt.

In 1990, the SWU contracted with the Sound Resource Management Group to analyze compost quality and environmental parameters. The material was tested for compost maturity, physical characteristics, seed germination, phytotoxicity, pesticide residues, heavy metals, and pathogens. The results showed that the compost met all existing state standards for yard waste composts.

The composting facility has had significant problems with odor emissions, resulting in public environmental concerns and complaints. In April 1991, an Analysis of Odors Report was submitted to the DPH by TRC Consultants on behalf of the Cedar Grove Composting Facility. The conclusion of the study was that the major sources of odors were the raw storage piles, ground material storage sites, and some windrows. The consultants suggested that certain actions be taken.

Based on this study, Cedar Grove drafted a Best Management Practices for Odor Control document and submitted it as part of its permit renewal application in 1991. Additional permit requirements were added to the renewed facility permit as a result. The facility is now required to have all compostibles shredded and windrowed within 4 days of delivery. Materials are to be aerated twice a week during the first 3 weeks in windrows and once a week during the last 3 weeks. The retention and detention basins were required to be equipped with an aeration pumping system. Continuous meteorological monitoring is required at the facility. Cedar Grove was also required to develop an odor complaint tracking and response system and contingency plans for handling complaints and occurrences. The facility was also required to evaluate the odor control potential of alternative feedstock management strategies, including feedstock adjustments, chemical oxidizers, and liquid bacterial solutions.

Odor complaints were substantially reduced in 1991 despite an increase from 59,000 to 75,000 in the tonnage processed. Some odor concerns resurfaced in November 1992 that were believed to be related to the by-product pile. The facility owner proposed moving and covering the by-product pile with an erosion layer. However, the DPH preferred to see a long-term rather than this short-term solution implemented and preferred the permanent removal of waste materials that had accumulated. By the end of FY 1992, the DPH and the facility owner were working to alleviate these odor problems.

Recycle America Materials Recovery Facility

The Recycle America Materials Recovery Facility began operations in 1988. At that time, given the nature and scale of the operation, no solid waste facility permit was required. However, as operations increased, recyclable materials began to be stockpiled outside the facility, and the Recycle America MRF became subject to the waste recycling facility standards. As mandated by the state code, the regulations and corresponding solid waste permit requirements are activated when recyclable waste regularly accumulates in outdoor piles prior to being processed. The solid waste permit application and SEPA checklist were submitted in June 5, 1992.

Waste recycling facilities are not subject to the General Requirements for Solid Waste Handling Facilities, but are subject to separate and less stringent general requirements for permitting. The facilities' permit applications are required to include a general description of the facility and the types of waste to be handled, an operating plan to include a surface water monitoring plan, and an inspection schedule and log.

Annual reports must also be submitted to the DPH detailing the quantities and types of waste recycled. the facility must comply with air quality standards for odors and dust, and must abide by a surface water program that minimizes runoff from outside storage piles. In addition, the facility operating plan must address litter control, dust and odor control, leak and spill prevention and corrective action, pest control, and surface and groundwater protection.

Surface and groundwater are protected by the Recycle America MRF through the use of two separate drainage systems. An NPDES permit was required for this activity.

After comment and clarification resulting from the WDOE, the DPH issued a Declaration of Non-Significant on September 3, 1992, thereby eliminating the need for the filing of a facility environmental impact statement. In October 1992, the DPH requested that the facility owner address issues related to water discharges and materials storage.

These issues were addressed, and the permit was issued on November 20, 1992. No complaints or additional environmental concerns have arisen regarding this facility or its operation since the issuance of this permit.

Rabanco/Recycle Seattle Recycling Center

The Rabanco/Recycle Seattle facility applied for a Solid Waste Recycling Facility Permit on April 30, 1990. As is the case for the Recycle America facility, the Rabanco facility is subject to the waste recycling facility standards. As such, the facility is not subject to the General Requirements for Solid Waste Handling Facilities, but is instead subject to separate and less stringent general requirements for permitting. The permit application for this facility requires inclusion of a general description of the facility and the types of waste to be handles, an operation plan to include a surface water monitoring plan, and an inspection schedule and log.

Annual reports must be submitted to the DPH detailing the quantities and types of waste recycled. The facility must comply with air quality standards for odors and dust, and must abide by a surface water program that minimizes runoff from outside storage piles. In addition, the facility operating plan must address litter control, dust and odor control, leak and spill prevention and corrective action, pest control, and surface and groundwater protection.

The facility was also required to obtain and comply with the permit conditions of a METRO Waste Discharge Permit. Any violation of the Discharge Permit requirements is also considered a violation of the Solid Waste Handling Permit. The facility also had to obtain a conditional use permit from the Department of construction and Land Use.

The facility was operated in compliance with its permit requirements in FY 1992.

Columbia Ridge Landfill

The Columbia Ridge Landfill is located in the state of Oregon and, therefore, is required to meet the Oregon Solid Waste Regulations, rather than the Washington State Solid Waste Regulations. The authority to regulate solid waste disposal facilities is granted under the Oregon Solid Waste Control Law.

Additional requirements pertaining to landfills govern operating practices with respect to leachate, groundwater protection, surface water protection, monitoring endangered species, gas control. surface drainage control, floodplains, cover material, cover frequency, access roads, access control, silt screening, fire protection, special handling, signage, truck washing, sewage disposal, salvage, litter, vector control, weighing, and record keeping.

Landfill disposal facilities must also file financial assurance plans assuring that the funds will be available to carry out all closure and post closure activities. These plans must include written cost estimates of all closure, monitoring, and postclosure activities, a detailed description of the form of the financial assurance, a method and schedule for proving for or accumulating the funds necessary, and a proposal for disposing of any excess moneys received or interest earned on moneys received for financial assurance.

A landfill facility is also required to submit a closure plan as part of the permitting process. The closure plan must specify the procedures necessary to completely close the land disposal site at the end of its operating life. The plan must also identify the activities that will be carried on after closure to properly monitor and maintain the completed land disposal site. Detailed plans and specifications must be submitted with a description of how and when the facility will be closed.

Oregon Waste Systems, Inc., the owner of the Columbia Ridge Landfill, began initial contacts with the county government and community regarding permitting and environmental issues in mid-1986. A Conditional Use Permit was granted in June 1987 by the county for establishing a landfill in the Exclusive Farm Use Zone. the application for the Solid Waste Disposal Facility Permit was filed by Waste Management of North America, Inc., on August 31, 1987. The approved solid waste disposal facility permit was issued by the

Oregon Department of Environmental Quality on May 18, 1988. Construction was completed at the end of 1989, and the site began receiving waste on January 2, 1990.

The facility's permit was renewed without change in 1989 and 1990. However, during late 1990 in preparing for the 1991 permit renewal, the facility applied for a permit modification to include certain changes. The renewed permit with all the requested modifications was approved and issued on June 10, 1991. The facility is estimated to be receiving many more than 100,000 tons of waste per month. Through FY 1992, the compliance history for the site has been characterized as very good.

Appendix A

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Appendix B

Glossary of Terms

ALLOCATED COST ($/YEAR):	That portion of the Total Cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
ANALYZED MSW:	That portion of the municipal solid waste (MSW) stream for which the cost of collecting, transferring, hauling, processing, combusting, marketing, and/or disposing of such waste is known or can be reasonably estimated.
AVERAGE COST:	($/ton: Total or Allocated Cost divided by the tons of MSW, garbage, trash, recyclables, or yard waste, as appropriate.
AVERAGE PROGRAM INCREMENTAL COST (SAVINGS) ($/ton):	The Program Incremental Cost divided by the number of tons of materials diverted from the landfill by the program.
BULKY WASTE:	Oversized items, including white goods and furniture, that have been separated form the MSW stream for separate collection.
COMMERCIAL MSW:	MSW that is generated by sources other than households, including businesses (e.g., offices, restaurants, retail stores, and industry), institutions (e.g., schools and government establishments), and public areas (e.g., train stations, airports, and litter from roadside).
GARBAGE:	Garbage is all MSW exclusive of source-separated trash, recyclables, yard waste, household hazardous waste, and bulky waste.
HAZARDOUS WASTE:	Waste which because of its quantity, concentration, or physical, chemical, or infectious characteristics, may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed *and* is defined as hazardous in accordance with federal and state laws. Does not include Household Hazardous Waste.
HOUSEHOLD HAZARDOUS WASTE (HHW):	Materials that are separated from Residential MSW as household hazardous wastes for separate collection and treatment. Such materials may include paints and solvents, pesticides, herbicides, and propane tanks.

INTEGRATED SOLID WASTE MANAGEMENT:	A practice of using several (i.e., two or more) alternative waste management techniques to treat, process, and/or dispose of the MSW stream. Alternative waste management techniques include source reduction, recycling, composting, combusting, and landfilling.
MARGINAL COST (SAVINGS) ($/ton):	The cost (savings) of managing *an additional* ton of MSW, garbage, trash, recyclables, or yard waste.
MARGINAL COST (SAVINGS OF SUBSTITUTION ($/ton):	The net cost (savings) of managing an additional ton of recyclables or yard waste less the savings (cost) of managing one less ton of garbage.
MATERIALS RECOVERY:	A term describing the extraction and use of materials from a waste stream.
MUNICIPAL SOLID WASTE (msw):	Nonhazardous solid wastes generated by households, commercial and business establishments, institutions, and light industry; it excludes industrial process wastes, agricultural wastes, mining wastes construction and demolition debris, offal, sludges, and ashes, except ashes derived from the combustion of MSW. In practice, specific definitions vary across jurisdictions.
PROGRAM INCREMENTAL COST (SAVINGS) ($/YEAR):	The difference between the cost of managing MSW with the inclusion of a particular program and the cost of managing MSW without that program (e.g., curbside collection, processing, and marketing of recyclables).
RECOVERED MATERIALS:	Recyclable materials that are recovered from MSW and may also include some contamination.
RECYCLABLE MATERIALS OR RECYCLABLES:	Materials that still have useful physical or chemical properties after serving their usefulness for a given individual or firm and can, therefore, be reused or recycled for the same or other purposes.
RECYCLE:	To convert discarded materials into useful products through reuse and remanufacturing.
RESIDENTIAL MSW:	MSW that is generated by households.
RESIDUE:	That portion of processed MSW that is ultimately disposed of in a landfill.

RESOURCE RECOVERY:	A term describing the extraction and use of energy or materials from a waste stream.
SECONDARY MATERIAL:	A material that is used in place of a primary or raw material in manufacturing a product; often handled by dealers and brokers in "secondary markets."
SELF-HAUL:	The delivery of MSW or other wastes to an integrated MSW management system by a private firm or individual that is not under contract to a municipality, authority, utility, or other public entity responsible for MSW management to make such deliveries.
TOTAL NET COST OR TOTAL COST ($/YEAR):	The aggregate of all expenditures incurred to manage MSW, inclusive of general and administrative, planning, capital, collection, processing, transfer and haul, marketing, promotion and education, and disposal costs, less any revenues derived from resource recovery activities.
YARD WASTE:	Vegetative material that is segregated from the MSW stream for separate collection and/or processing, including grass, prunings, plants, and small tree limbs, but excluding tree stumps, land-clearing debris, and other large vegetative matter (see Brush).
WHITE GOODS:	That portion of bulky waste which consists of large appliances, such as refrigerators, stoves, washing machines, and dryers.

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1. Introduction

Seattle, Washington ("the City"), is a medium sized city with approximately 516,000 residents. In 1990, there were 249,032 households of which 132,330 were single-family dwelling units, 113,146 multi-family dwelling units (22,641 in buildings of two to four units; 71,285 in five to 49 units; and 19,220 in buildings with 50 or more units), and 3556 households in mobile homes, trailers, and other dwellings. Its containerized shipping facilities are among the largest in the world.

Seattle is the largest metropolis in the northwestern United States and is the seat of King County, Washington. The mainstay of the region's economy has long been the aircraft industry. Shipbuilding and wood products manufacturing are the other major industries in Seattle. In addition, the City has long been a major port for trade to Asia and the principal gateway to Alaska.

The City is located on a narrow, hilly isthmus between Puget Sound on the west and Lake Washington on the east. It lies between two major mountain ranges: the Cascades to the east and the Olympics to the west. While the City receives an average of only 35 inches of precipitation annually, there is measurable rainfall on an average of 150 days per year Average temperatures range from 41°F in January to 64°F in July.

During fiscal year 1992, which extended from January 1 through December 31, 1992 (FY 1992), about 542,000 tons of municipal solid waste (MSW) were generated in Seattle.[1] The City manages the collection and disposal of this MSW through the Seattle Solid Waste Utility ("the Utility" or "SWU"). The Utility is one of only three such bodies in the State of Washington.

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[1] This tonnage is exclusive of any recyclables diverted from the waste stream by commercial establishments and other private recycling programs.

2. The City's Integrated Solid Waste Management System

2.1 The Solid Waste Utility

The Utility was established in 1961 as a division of the City's Department of Engineering. Its three primary functions are:

1. providing direct services (transfer stations and long-haul transport) for the disposal of MSW;

2. purchasing services for the collection of recyclables, garbage, and yard waste; the processing of recyclables; the disposal of MSW; and consulting services; and

3. managing an integrated solid waste management system, including program planning, administration, and evaluation; rate-setting; budgeting and finance; and community relations.

The Utility operates as an independent financial entity that must be self-supporting, i.e., it can receive no subsidies from general funds or tax revenues. Therefore, the Utility must charge fees to cover its costs. The fees the Utility charges its customers are variable, or volume-based, rates. Customers are divided into three different residential classes: single family, multi-family, and low income (containing both single and multi-family customers). Customers subscribe to the level of service (which includes a given size and number of containers) that is compatible with their household size. Additional cans beyond that provided in the subscription level are subject to additional charges. The Utility also uses a pre-paid sticker system to charge for extra wastes not contained within the cans. Customers are billed for Utility services through the Combined Utility Billing System (CUBS), which is operated by the City's Water Department. The CUBS combines billing for the City's sewer, water, and solid waste services.

The Utility has the authority to control the disposition of residential and commercial MSW, exclusive of "materials destined for recycling," generated within the City's borders, pursuant to the 1991 Seattle flow control ordinance.[2] Municipal solid waste collection, processing, and disposal services to residential customers are provided through contracts between the Utility and private haulers. However, the Utility owns and operates two transfer stations and maintains a hauling fleet for transport of materials from the transfer stations to the local Union Pacific railhead for rail-hauling to an Oregon landfill, and yard waste to the Cedar Grove Composting Facility.

2.2 System Overview

The City's 1992 Integrated Municipal Solid Waste Management (IMSWM) System consisted of the following integrated system components:

- separate collection of residential garbage, yard waste, and recyclables by private firms under contract to the Utility;

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[2] City of Seattle Ordinance 115589, enacted March 25, 1991.

- two transfer stations (North and South) owned and operated by the Utility;
- a household hazardous waste (HHW) drop-off site located at the south transfer station;
- two privately owned and operated materials recovery facilities (MRFs);
- a privately owned and operated yard waste composting facility;
- a rail yard, referred to as the railhead, for the intermodal transfer of sealed containers of MSW; and
- a landfill, located in Oregon, for the disposal of garbage.

The locations of the facilities that constitute the City's IMSWM System are shown in Figures 2-1 and 2-2.

In addition the Utility performs or sponsors a number of other functions and programs, including promoting backyard composting and managing the closure of landfills.

Municipal solid waste managed by the City is categorized in this report as garbage, bulky waste, yard waste, and recyclables. Household hazardous wastes (HHW) are also collected from residents who choose to haul it to the City's HHW drop-off site. Figure 2-3 is a graphical representation of the components of MSW. The reader is advised to peruse the Glossary of Terms in Appendix A for a more detailed definition of these and other terms used in this document.

A description of each of the individual components of the City's IMSWM System follows.

2.3 System Component Descriptions[3]

2.3.1 Collection

Residential garbage is collected by two local firms that separately service northern and southern sectors of the City under contract to the Utility. General Disposal provides weekly garbage collection to the two northern sectors of the City, while U.S. Disposal, a subsidiary of Rabanco, provides weekly garbage collection for the southern sector of the city (see Figure 2-4). Both companies began seven-year contracts with the Utility in January of 1989.[4] Under these contracts, customers were offered, for the first time in the Utility's history, a choice between

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[3] Much of the information presented in this section was obtained from the "Road to Recovery" series of documents published by the SWU. See the reference section for more details.

[4] "Solid Waste and Yard Waste Collection Contract," City of Seattle and General Disposal Corp., January 1, 1989 - March 31, 1996; and "Solid Waste and Yard Waste Collection Contract," City of Seattle and U.S. Disposal, January 1, 1989 - March 31, 1996.

FIGURE 2-1:
LOCATION OF SEATTLE IMSWM SYSTEM FACILITIES

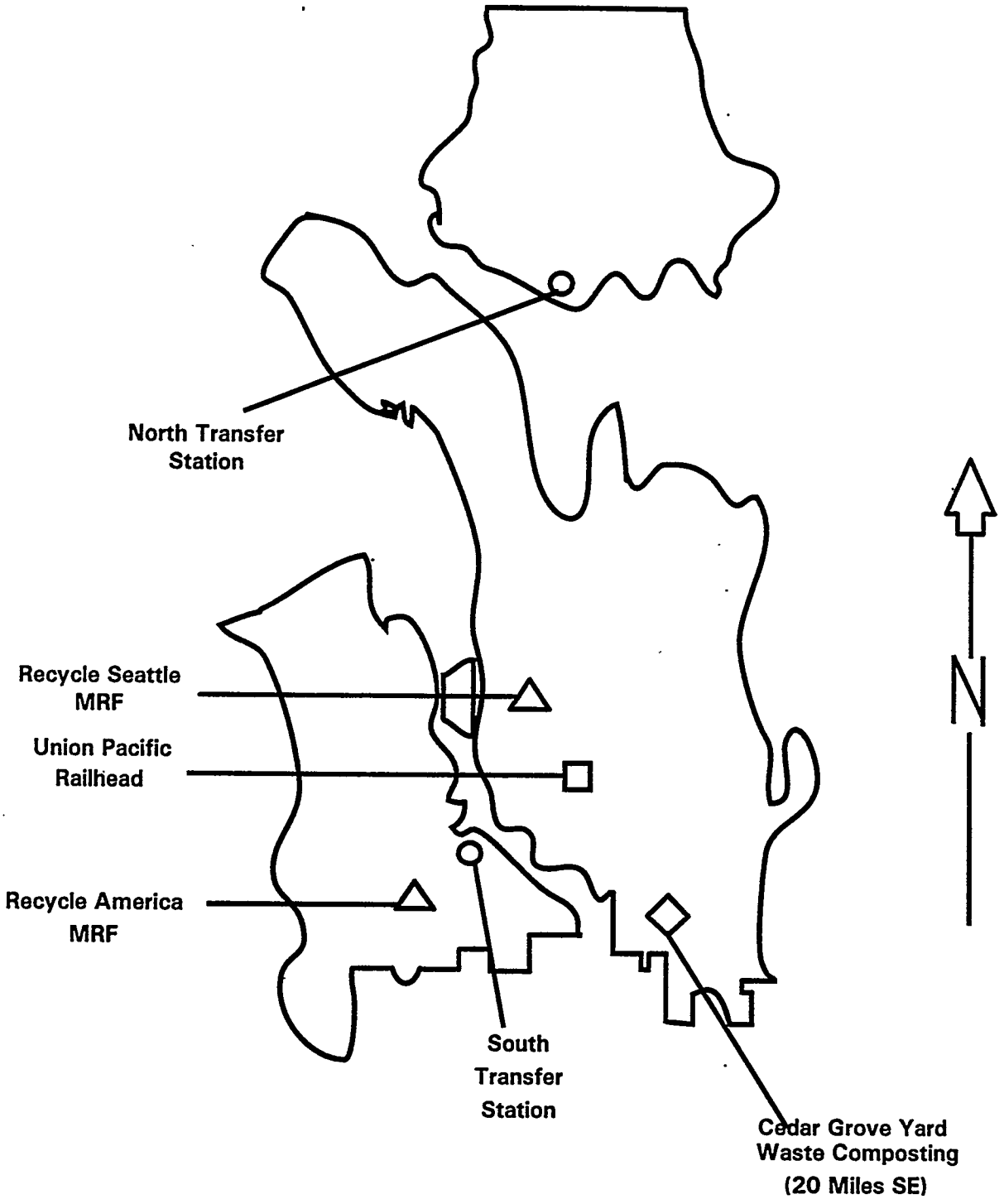


FIGURE 2-2: COLUMBIA RIDGE LANDFILL LOCATION

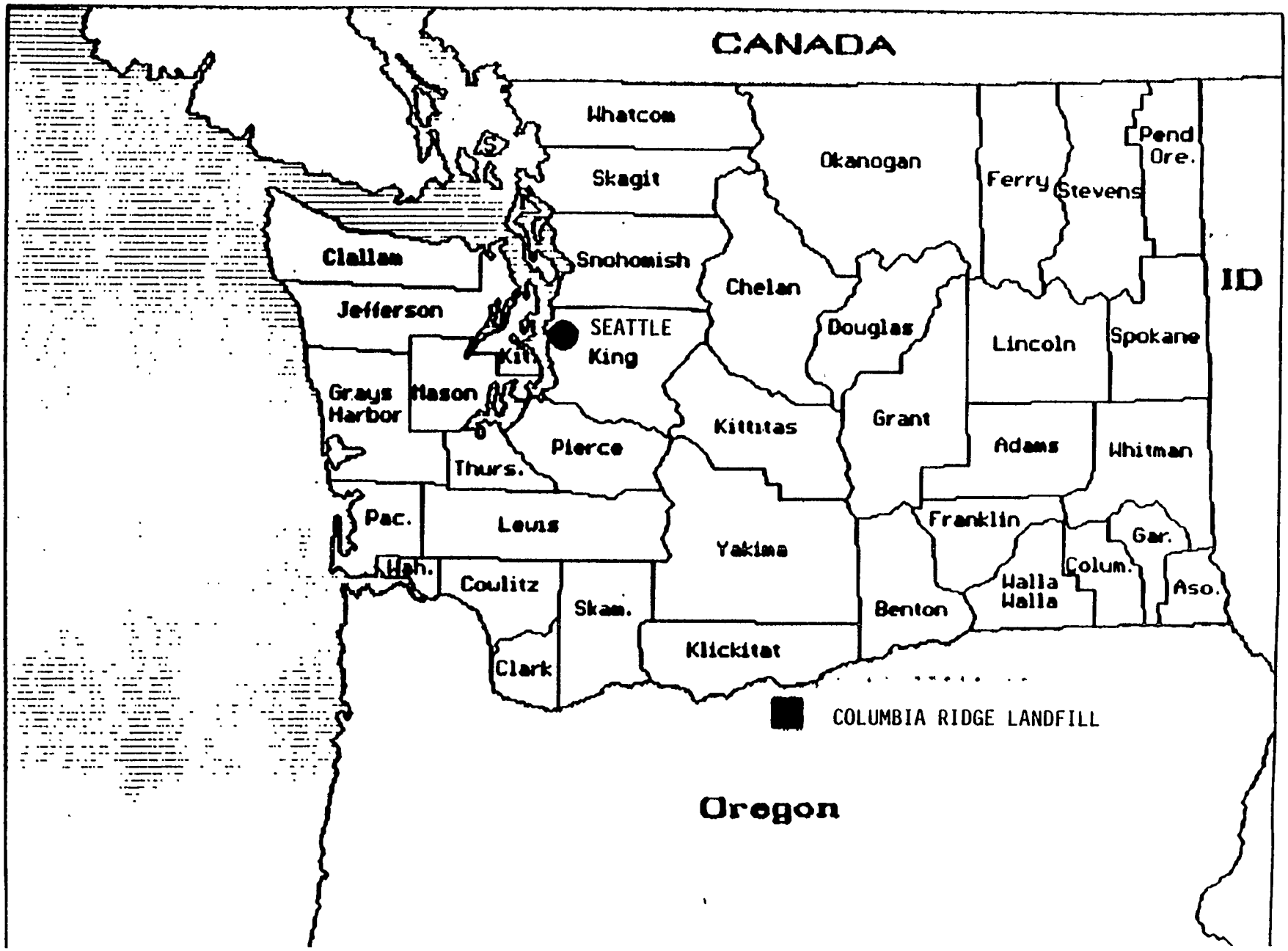


FIGURE 2-3: MSW: DEFINED CONSTITUENTS

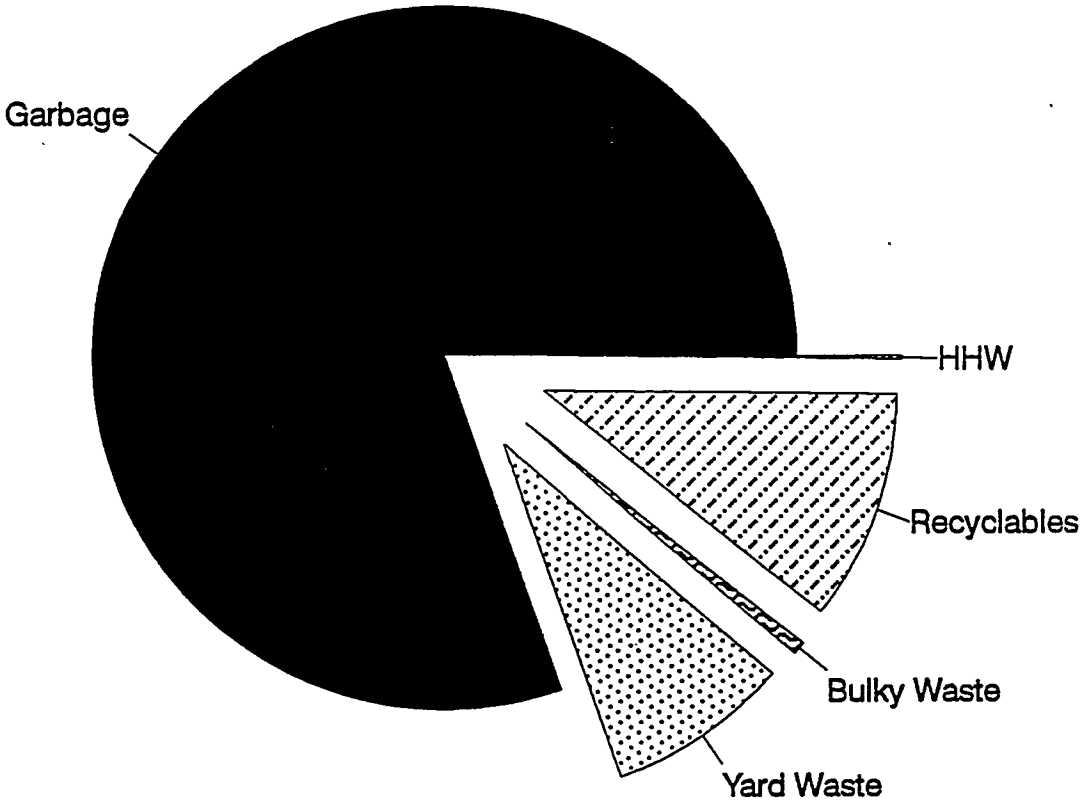
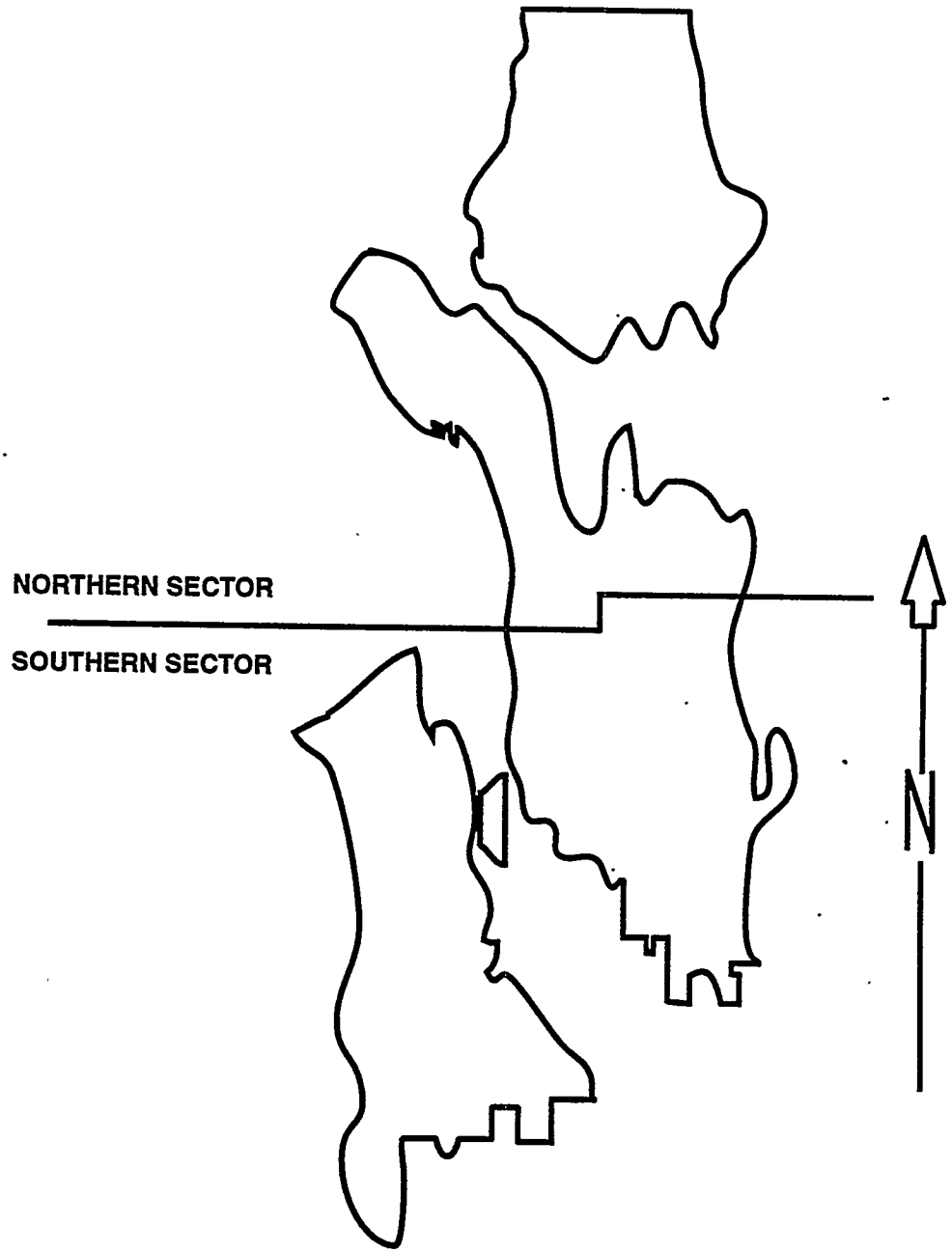


FIGURE 2-4: SEATTLE'S NORTHERN AND SOUTHERN SECTORS AS DESIGNATED FOR YARD WASTE COLLECTION



curbside/alley collection and backyard collection, and given a 40-percent rate-reduction incentive for choosing curbside/alley collection.

General Disposal uses side-loading trucks with one-person crews for most of its collection. U.S. Disposal uses rear-loading trucks with two-person crews. Collection is provided weekly to customers, with the exception of apartment buildings. Because apartments may require multiple collections, one collection is provided on the usual collection day for the area in which the building is located, and additional collections are made by an assigned apartment crew (usually one-person) on other days. A few apartment buildings receive Saturday service. All collected residential garbage is delivered to one of the two City-owned transfer stations.

Yard waste is also collected by General Disposal in the northern sectors of the City and by U.S. Disposal in the southern sectors. General Disposal collects yard waste every week on the same day as it collects garbage. U.S. Disposal collects yard waste on a bi-weekly basis from March through September and on a monthly basis from November through February. U.S. Disposal also collects yard waste on the same day as it collects garbage. Both firms use 20-cubic-yard rear-loading packer trucks. U.S. Disposal delivers its collected yard waste either to the Rabanco transfer facility or directly to the Cedar Grove composting facility, where it is processed. General Disposal delivers its collected yard waste to the City's South Transfer Station. The City then transfers this yard waste to 40-foot trailers and transports it to the Cedar Grove composting facility.

Residential recyclables are collected (from single family through four-plex households) and processed by two separate firms under contract to the Utility for separate northern and southern sectors of the City (see Figure 2-5).[5] The northern sector is serviced by Recycle America, a subsidiary of Waste Management Industries (WMI), while the southern sector is serviced by Recycle Seattle, a Rabanco subsidiary. Recyclable materials collected include: glass bottles and jars, newsprint, aluminum cans, tin cans, mixed paper, PET and translucent and opaque HDPE plastic containers.

Recycle America collects source-separated recyclables placed into the three 14-gallon, stackable bins it provides to each participating resident. Residents put newspaper into one bin, mixed paper into a second bin; and glass, tin, aluminum, PET, and translucent and opaque HDPE plastics into the third bin. Collection is performed weekly. Until recently, these materials were collected by 20-cubic-yard, three-compartment, manual-loading trucks. However, these small-capacity trucks became inadequate for handling the increasing amounts of recyclables collected. Therefore, collection is now accomplished using large-capacity, automated, top-loading trucks. The collected recyclables are delivered to the Recycle America's MRF, depicted in Figure 2-6, located in south Seattle. In 1992, 64,000 of 70,000 eligible households signed up for service in the northern sector recycling program.

Recycle Seattle collects commingled recyclables placed into the one 90-gallon cart it provides to

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[5] "Home Collection of Source Separated Recyclable Materials Contract," City of Seattle and Recycle America, October 21, 1987 - December 31, 1992, and "Home Collection of Source Separated Recyclable Materials Contract," City of Seattle and Recycle Seattle, January 1988 - February 18, 1993.

FIGURE 2-5: SEATTLE'S NORTHERN AND SOUTHERN SECTORS AS DESIGNATED FOR RECYCLABLES COLLECTION

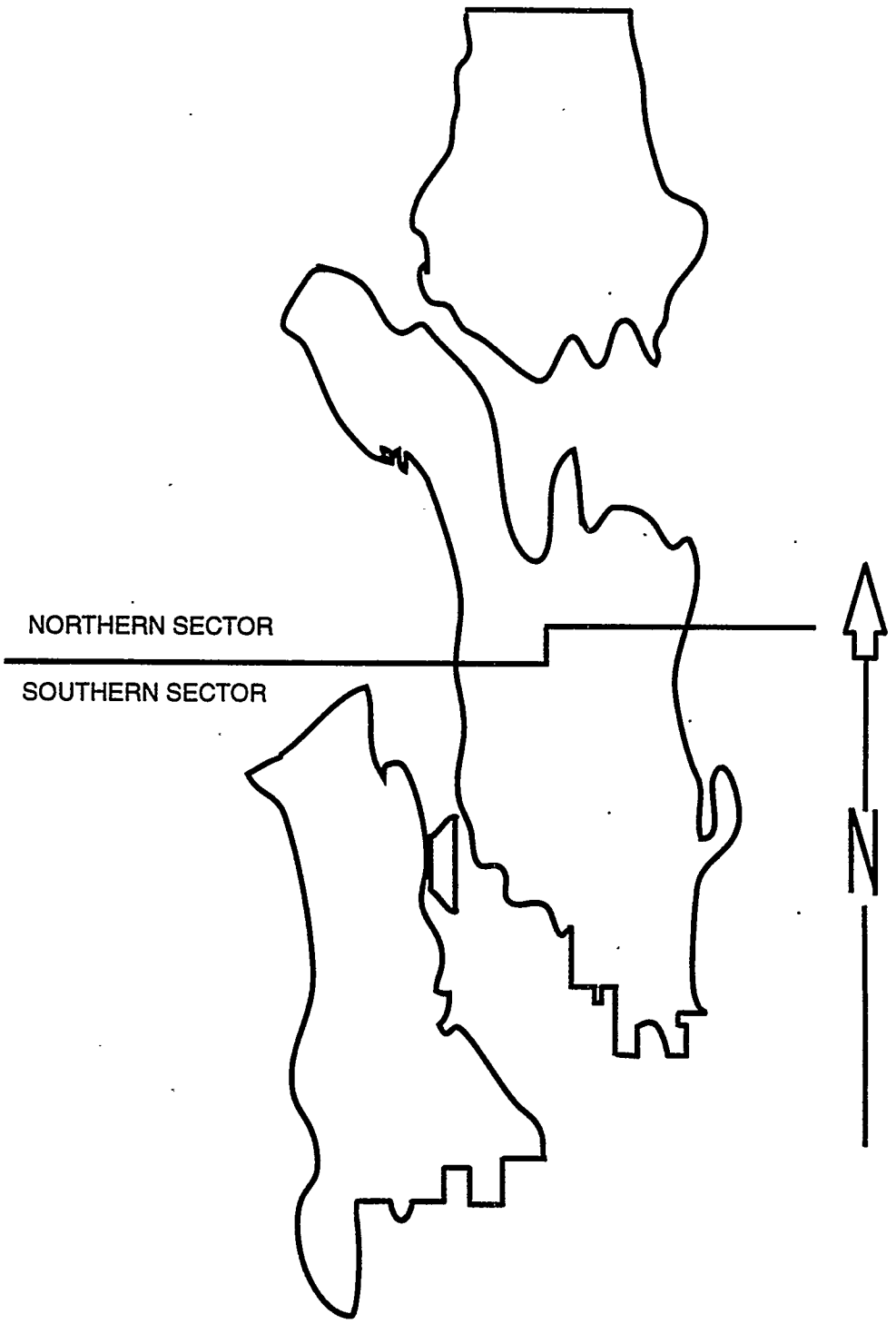
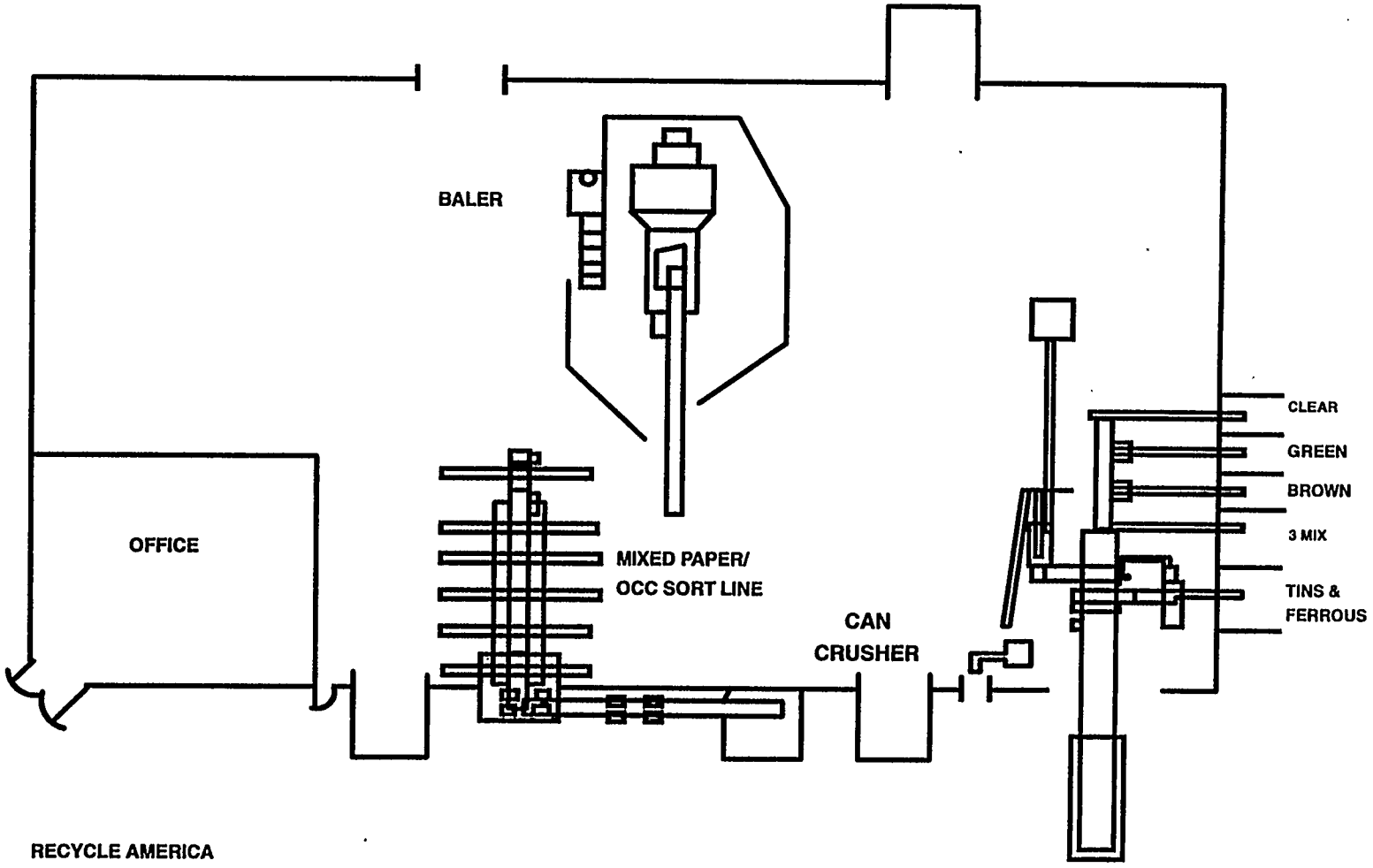


FIGURE 2-6
RECYCLE AMERICA MRF



RECYCLE AMERICA
WASTE MANAGEMENT, INC.
SEATTLE, WASHINGTON

NOT TO SCALE

each participating resident. Recyclables previously had been collected by 20-cubic-yard, rear-loading garbage trucks. However, this caused the problem of glass contamination at the recyclables processing facility. Therefore, during the latter half of 1992, Recycle Seattle switched to packer trucks, modified to include compartments behind the cab for source-separated glass.[6] Collected recyclables, which include the same materials collected by Recycle America, are delivered by Recycle Seattle to the Rabanco MRF, depicted in Figure 2-7, which is also located in south Seattle. In 1992, 64,600 of 78,500 eligible households signed up for service in the southern sector recycling program.

As mentioned above, residential recyclables collection is only provided for single-family through four-plex households. Apartment collection is not included within the contracted services. However, recent negotiations with other independent curbside collectors have resulted in the initiation of apartment recyclables collection. Two other private recycling firms also collect from apartments. In addition, the apartment diversion credit program has provided recycling services to a small subset of multi-family buildings with five or more dwelling units. Under this program, the City pays a private recycler for each ton of recyclables diverted from the apartment building waste streams. Targeted materials include newspaper, glass, and tin and aluminum cans.

In addition to curbside recyclables collection, over 40 privately owned buy-back and drop-off facilities are located in Seattle. Residents are free either to drop off their recyclables, generally to facilities run by charities, or to be paid for delivering their recycling to privately run buy-back centers.

While the Utility is not responsible for commercial waste collection, businesses and industries in Seattle are served by four collection companies that hold certificates from the Washington Utilities and Transportation Commission (WUTC). Seattle Disposal (owned by Rabanco) and Bayside Disposal (owned by Waste Management) collect commercial mixed waste and demolition debris as well as recyclables. Halffman Trucking and Montleon Trucking are limited to collecting construction and demolition waste. Collection is regulated by the WUTC, which in turn is monitored by the City. The City establishes recycling service levels, rate structure requirements, and data-reporting requirements for the WUTC through its integrated solid waste management plan.

2.3.2 Transfer Stations

Residential garbage collected by General Disposal and U.S. Disposal is taken to one of two City-owned and operated transfer stations -- the North Transfer Station or the South Transfer Station. The South Transfer Station also accepts yard waste collected by General Disposal, which is then transported by the City to the Cedar Grove composting facility in 40-foot trailers. Household hazardous waste is collected at the South Transfer Station (through residential drop-off) and disposed of separately.

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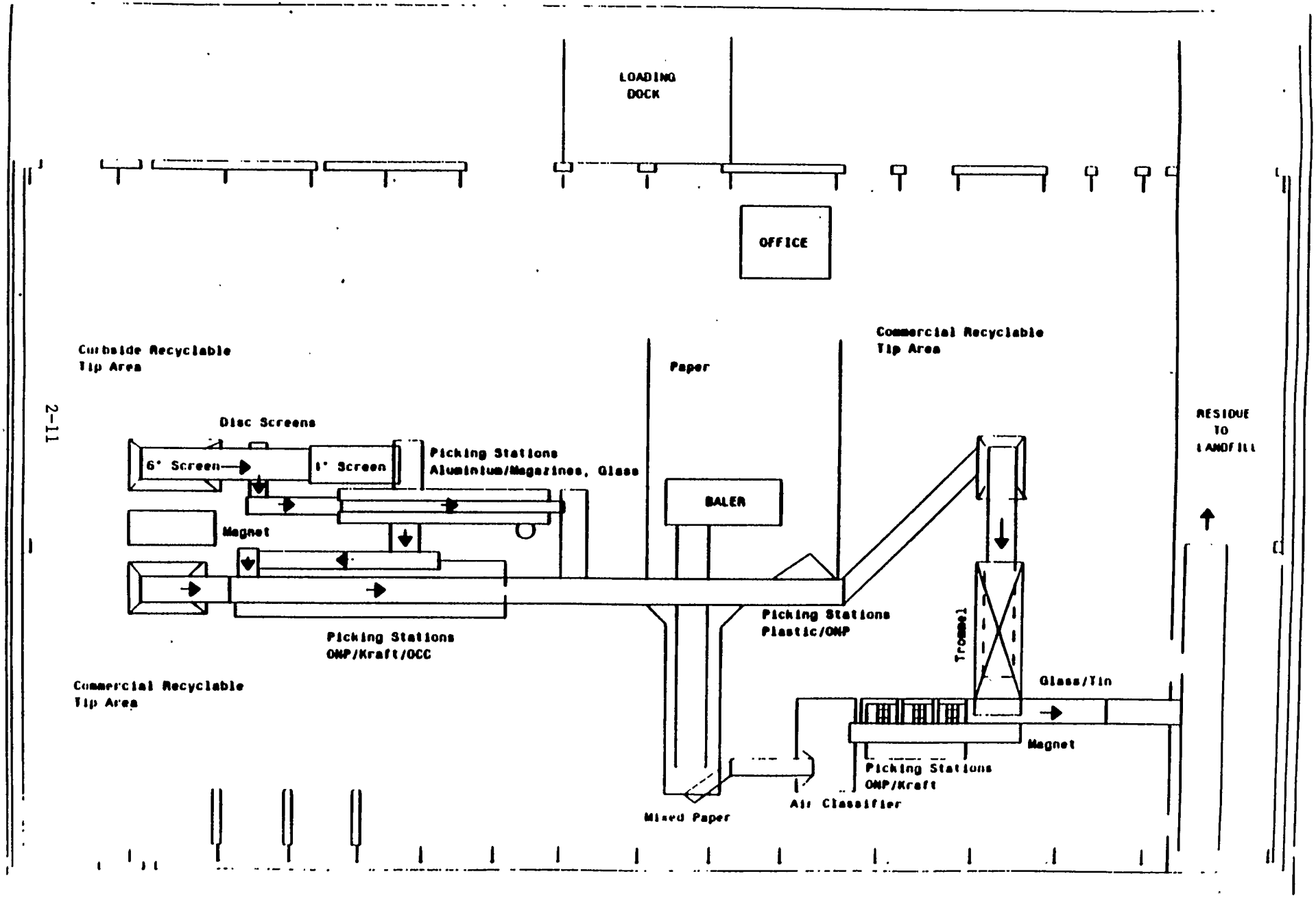
[6] To reduce the problem of glass contamination and improve the recovery efficiency of glass, Recycle Seattle provided homeowners with inserts that hang outside the cart on the top rim for the purpose of holding glass containers separate from the remaining commingled recyclables in the cart. The driver of the collection truck sorts the glass by color at the curb.

FIGURE 2-7: RECYCLE SEATTLE (RABANCO) MRF



The North and South transfer facilities were constructed in 1966 and 1968, respectively. Each has a design capacity of 1,000 tons per day and measures 28,800 square feet. It is estimated that this capacity is more than adequate to handle the annual Seattle waste stream forecasted to be disposed of until the year 2010.

Residential garbage accounts for approximately two-thirds of the MSW handled at the transfer stations. Wastes that are self-hauled by City residents account for less than ten percent of the waste handled at the transfer stations. Waste self-hauled by commercial businesses and delivered by haulers who collect from commercial customers accounts for 28 percent of the waste handled at the stations. (Self-hauled waste can include household garbage, bulky items or white goods, yard waste, and recyclables that are deposited at the drop-off boxes at the two transfer stations.)

Operations at the two City transfer stations has remained generally unchanged over the years, until recently, when the recycling containers were installed. Also, garbage had previously been dumped either into a storage pit or directly into transfer trailers below ground level. Garbage dumped into the pit was then bulldozed into the transfer trailers. The trailers were stored on-site until they were picked up by long-haul trucks for transport to King County's Cedar Hills Landfill. However, since the recent shift to rail-hauling waste to the Oregon landfill, operations at the transfer stations have been modified. Solid waste is now compacted, in 25- to 28-ton loads, into 40-foot, waterproof, sealed shipping containers mounted on trailer chassis. The shipping containers are then taken to the railhead for transport to the Oregon landfill.

In addition to the two City-owned transfer stations, two privately owned transfer facilities that handle primarily commercial wastes are also located in Seattle. One, the Rabanco Recycling Center, is owned and operated by Rabanco. This transfer station receives three types of waste: clean paper loads, industrial or demolition waste, and mixed garbage loads. Seattle Disposal, the Rabanco-owned commercial collection company, routes its collection trucks to collect these waste streams separately. The other, the Eastmont Development Transfer Station, is owned and operated by Waste Management and serves Bayside Disposal and other collection firms operated by Waste Management in the Seattle area. This transfer station receives mixed waste collected from commercial and industrial accounts inside and outside the City and residential waste collected from outside the City.

2.3.3 Materials Recovery and Recycling

Once residential recyclables are collected in Seattle they are taken to each of the two collection contractors' MRFs: the Rabanco Recycling Center and the Recycle America Processing Center.

The Rabanco Recycling Center, which processes the recyclables collected by the Rabanco subsidiary, Recycle Seattle, opened in 1988. The center is an 80,000-square-foot commingled recyclables processing facility designed to process 500 to 700 tons per day of recyclables, including: clean paper, newspaper, cardboard, plastics, paper-rich commercial loads, and commingled recyclables from curbside collection programs. It uses a combination of conveyors, trommels, disc screens, magnetic separation, air classification, hand picking, and bailing to recover and process recyclable materials, as was shown in Figure 2-7.

The Recycle America Processing Center was opened by Waste Management in 1988. This

43,000-square-foot facility processes source-separated recyclables collected from Recycle America's curbside program. Collected materials include newspaper, cardboard, mixed paper, tin, glass, aluminum, and plastic. Since recyclables are collected in compartmentalized trucks, the facility is primarily used for hand-sorting and bailing and has a capacity of 400 tons per day. Sorting of glass, tin, and aluminum is done through a combination of magnets and hand-sorting, as was shown in Figure 2-6. The facility is also designed to process commercial loads rich in cardboard and paper.

2.3.4 Yard Waste Processing and Composting

In 1988, a City ordinance mandated that yard waste be separated from garbage. The City began a three-part program consisting of: (1) backyard composting, for which customers received free in-home instruction on composting techniques and a free composting bin; (2) curbside yard waste collection, whereby up to 20 cans, bags, or bundles of yard waste are collected for a small monthly fee by the contractors collecting regular household garbage; and (3) expansion of the transfer station "Clean Green" collection program, whereby yard waste can be self-hauled to the two City transfer stations.

All yard waste collected through curbside collection and the Clean Green transfer station programs is processed at the Cedar Grove Composting Facility, located in Maple Valley, Washington, approximately 20 miles southeast of Seattle in rural King County. This facility is owned and operated by the Cedar Grove Compost Company, a subsidiary of Northern Environmental Industries. Yard waste collected by U.S. Disposal is either taken directly to the Rabanco transfer station, from where it is hauled to Cedar Grove, or directly hauled to Cedar Grove. Yard waste collected by General Disposal is delivered to the South Transfer Station, where it is then transferred by the City to the Cedar Grove facility.

The Cedar Grove facility opened in early 1989 and currently has a capacity of approximately 100,000 tons per year. Cedar Grove accepts Seattle's yard waste as well as that of other nearby communities and commercial self-haulers. Materials delivered to the composting facility are visually inspected and then shredded by a hammermill or tub grinder. A conveyor belt system and metal detector are used to screen the material before it enters the hammermill. Yard waste is then placed in windrows for six weeks and turned by a Scarab once a week. The product is then placed in a curing pile for at least six weeks to stabilize. The compost is then screened to remove plastic residue, rocks, and wood fragments.

2.3.5 Rail Haul and Landfilling

While a significant portion of Seattle's municipal solid waste stream is recovered through recycling, reuse, and composting, the balance requires disposal. The City closed its last remaining landfills in 1983 and 1986, and both were subsequently declared Superfund sites. Seattle then turned to King County's Cedar Hills Landfill, at which point disposal costs more than doubled. In 1988, Seattle decided to implement an aggressive recycling program and dispose of the remaining waste in a landfill to be developed east of the Cascade Mountains.

Following the 1989 issuance of an RFP for transportation and landfill services and review of the responses, the Utility began negotiations with Washington Waste Systems, a subsidiary of Waste Management, Inc., in November 1989. Washington Waste Systems proposed to rail-haul

Seattle's waste to its landfill in Gilliam County, Oregon.

In addition, the company agreed to attempt to site and develop a landfill in eastern Washington, and give the Utility the option to switch to that landfill by 1995. A 30-year contract between the Utility and Washington Waste Systems was put into place by 1990, and rail-hauling to, and disposal at, Washington Waste System's Columbia Ridge Landfill (Gilliam County, Oregon) began in 1991.

The Utility, as well as private haulers, deliver containerized waste to the Union Pacific railhead in Seattle. Private haulers must pay a tip fee for waste delivered to the railhead. At the railhead, each container is weighed, and container information is entered into a computerized manifest and container tracking system. The waste is then loaded onto the train, which is composed of approximately 50 railcars, carrying 100 "piggybacked" containers. Washington Waste Systems provides all railcars, shipping containers, intermodal lift equipment, and landfill equipment. The Utility and private transfer station operators provide their own compactors, tractors, and chassis to haul containers from transfer stations to the railyard.

The loaded train leaves Seattle three evenings a week and travels 300 miles to the Columbia Ridge Landfill, where it arrives early in the morning. Washington Waste Systems personnel unload the containers and place them on truck chassis to be delivered to the landfill face. Hydraulic tippers tilt the chassis and containers to dump the waste, which is then immediately spread and compacted. It is covered each day with six inches of compacted dirt.

The Columbia Ridge Landfill facility also houses a recycling center and is located on a 2,000-acre site. The landfill disposal site occupies 640 acres and is divided into 20 distinct cells. It includes a composite liner system and leachate collection system. A monitoring system, including gas monitoring probes, groundwater monitoring wells, and vadose zone monitoring, is also in place.

2.3.6 Household Hazardous Waste

A permanent household hazardous waste collection facility is housed within the City's South Transfer Station site. This facility began accepting HHW in 1988, and during its first full year of operation accepted about 80 tons of HHW. By 1992, that amount had increased to approximately 250 tons. Types of HHW collected include: latex paint, solvent-based paint, paint-related wastes (e.g., thinners, stains, varnishes, etc.), solvents, pesticides, and corrosives (acids and bases, mainly found in cleaning products and miscellaneous chemicals). The facility is open Thursday through Sunday year-round.

The facility is constructed as a drive-through facility using pre-fabricated storage containers on a concrete slab. The work area is covered by a canopy with a pre-fab office added later. Customers drive onto the site, where facility staff members remove the HHW from their vehicles. Customers remain in their vehicles during the removal process and are asked to fill out a form indicating the sources and types of materials brought to the facility.

The majority of the materials collected at the HHW facility are brought to one of two final destinations. Materials with remaining energy value are used as an alternative fuel for a federally permitted cement kiln in Kansas. Pesticides, poisons, and other materials without energy value

are disposed of in a hazardous waste landfill in Oregon.

Both of the City's transfer stations accept used motor oil. The Utility has also placed collection tanks for used oil at many area auto supply stores. The tanks are accessible only during store hours and store personnel are responsible for day-to-day maintenance. The Utility provides the tanks, contracts with a hauler for collection of the oil, and arranges for disposal of contaminated oil.

2.3.7 Other Waste Management Programs

2.3.7.1 Backyard Composting

Seattle has been promoting home composting since 1978. In 1980, the City conducted its first home-composting pilot program and hired a compost coordinator to operate and staff five neighborhood compost sites. In 1985, Seattle established its Master Composter Program, a formal training program for home composting. Volunteers receive classroom and hands-on training, participate in internships, and do community outreach work to become Master Composters. These volunteers then return to their communities to teach residents about home composting.

During late 1989 and early 1990, Seattle stepped up its efforts to encourage backyard composting by distributing compost bins to 6,000 City residents. By 1992, well over 25,000 bins had been distributed. The composting bins used now, called the "Seattle Composter," come in two sizes: 21 cubic feet and 12 cubic feet. They are made of recycled HDPE collected from Seattle's eight plastics drop-off sites. Each bin has a life expectancy of 10 years.

2.3.7.2 Landfill Closure Projects

In the 1960s, Seattle leased two sites in the neighboring city of Kent (15 miles south of Seattle) to serve as landfills for the City's wastes. One, the Midway Landfill, was an abandoned gravel pit and was used primarily for the disposal of demolition debris and some industrial waste. The other, the Kent Highlands Landfill, sat atop a deep, undeveloped ravine and was used for disposal of residential solid waste. By the early 1980s, both sites were reaching capacity. Midway stopped receiving waste in 1983. Two years later, combustible gas was discovered to be migrating from the site, which later led to an evacuation of the surrounding area. In 1986, the EPA declared Midway a Superfund site. The Kent Highlands Landfill reached its capacity and closed at the end of 1986. In 1990, the EPA placed it on the Superfund site list as well.

In order to determine the activities necessary for closure of the two landfills, the Utility conducted extensive investigations of landfill gas, air quality, surface water, groundwater, and soils and seeps. The studies took more than two years to complete and required numerous gas probes and groundwater monitoring wells. Thousands of samples were collected and analyzed using a broad range of chemical tests. Closure of the two landfills involved installation of gas control systems and surface water management systems, capping, and final cover. In addition, the City established a program to guarantee that local property values would not be affected, which involved City purchases of homes that could not be sold at fair market value.

3. MSW and Other Waste Collected, Processed, and/or Disposed of in Seattle

A total of approximately 542,000 tons of MSW and other waste material was processed or disposed of by the Utility in FY 1992. Of this amount, about 80.2 percent was garbage, 8.5 percent was yard waste, and 10.4 percent was recyclables. The remaining 0.9 percent consisted of white goods, HHW, and wood wastes. Table 3-1 summarizes the tonnage collected, processed, and/or disposed of by the Utility in FY 1992.[7] This tonnage does not include recyclables that are segregated from the MSW stream for recycling by commercial and business establishments. Therefore, the data in this table does not provide a complete account of recycling activities in Seattle.[8] A waste flow and resource recovery diagram of the waste stream processed through the Utility's IMSWM System is depicted in Figure 3-1.

In the following Sections 3.1 through 3.7, the types and quantities of waste collected, processed, and/or disposed of by the Utility during FY 1992 are presented in detail.

3.1 Garbage and Yard Waste Collection and Transfer

All residential MSW generated in the City is collected by private companies under contract to the Utility. In FY 1992, garbage and yard waste collection services were provided by General Disposal Corporation ("General Disposal") and U.S. Disposal. General Disposal collected 96,679 tons of garbage and 24,547 tons of yard waste from the northern sector of the City, while U.S. Disposal collected 45,475 tons of garbage and 10,243 tons of yard waste from the southern sector. (See Figure 2-4 for approximate geographic area of each sector.)

Garbage collected by General Disposal was delivered to the City's North Transfer Station; garbage collected by U.S. Disposal was delivered to the City's South Transfer Station. Yard waste collected by General Disposal was delivered to the City's South Transfer Station, and yard waste collected by U.S. Disposal was delivered either to Rabanco's transfer station, located in the southern section of the City, or hauled directly to the Cedar Grove composting facility.

Both of these contractors were also responsible for the collection of bulky waste within their

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[7] Tonnage values presented were obtained from monthly invoices of the various contractors and various summary reports prepared by the SWU. See the references section for citations.

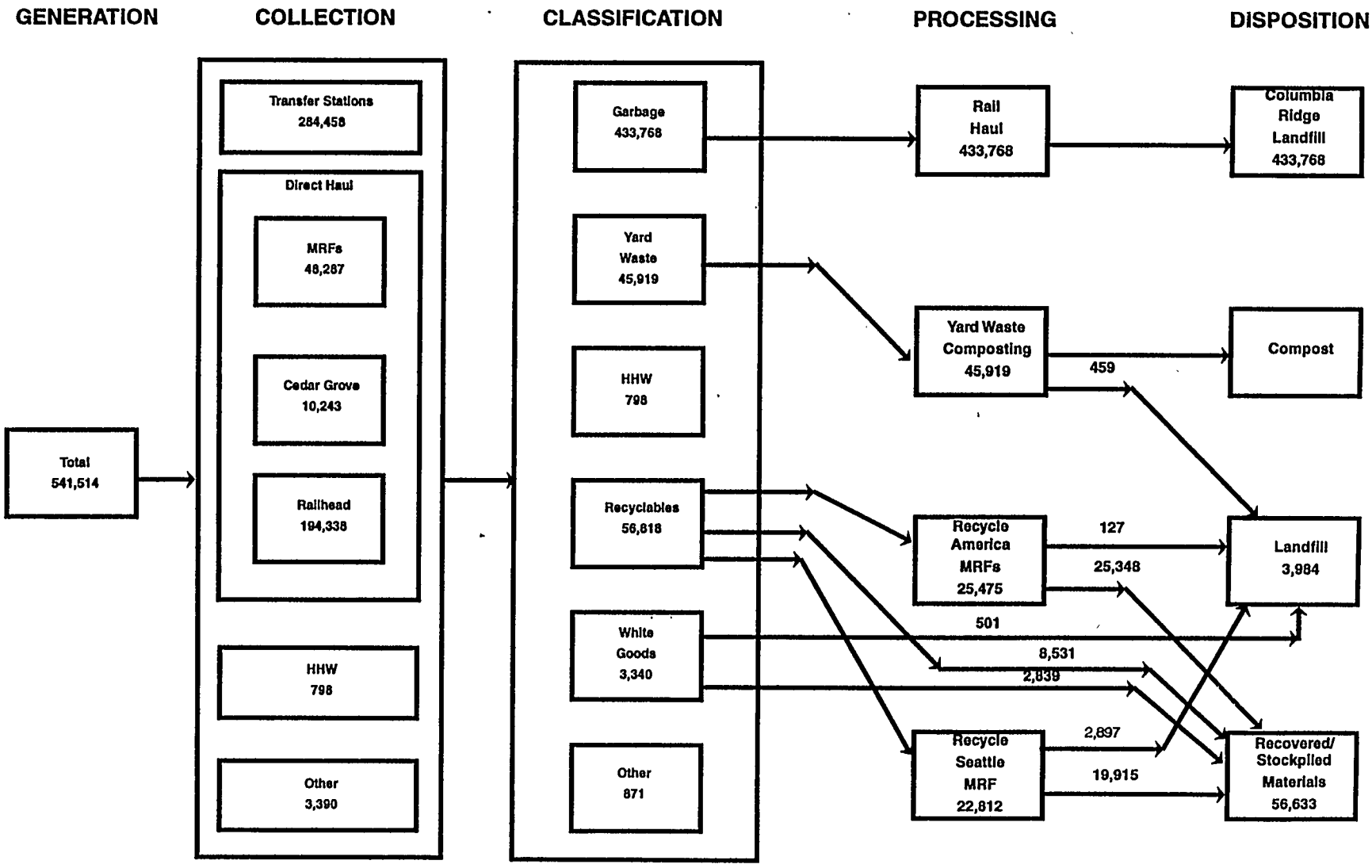
[8] The Utility reported that approximately 41 percent of the residential and commercial solid waste generated in Seattle in 1992 was recycled. About 65 percent of the material recycled, or about 195,300 tons, was done through private activities. The balance, or about 106,900 tons, was recovered through Utility-sponsored programs (e.g., curbside recycling, yard waste composting, white good recycling, recycling drop-off, apartment recycling, and wood waste recycling). (SWU, "Summary of Recycling Program Impacts," Computer Output, April 21, 1994.)

TABLE 3-1: MSW AND OTHER WASTES COLLECTED, PROCESSED, AND/OR DISPOSED OF IN SEATTLE IN FY 1992

WASTE TYPE	PERCENT	TONS
MSW		
GARBAGE		
General Disposal	17.9	96,679
U.S. Disposal	8.4	45,475
Self Haul to Transfer Station	18.0	97,276
Self Haul to Railhead	35.9	194,338
Subtotal Garbage	80.2	433,768
YARD WASTE		
General Disposal	4.5	24,547
U.S. Disposal	1.9	10,243
Self Haul to Transfer Station	2.1	11,129
Subtotal Yard Waste	8.5	45,919
RECYCLABLES		
Recycle America	4.7	25,475
Recycle Seattle	4.2	22,812
Apartment Recycling	0.5	2,973
Self Haul to Transfer Stations	0.9	5,141
Other (e.g., plastic drop off)	0.1	417
Subtotal Recyclables	10.4	56,818
WHITE GOODS	0.6	3,340
HOUSEHOLD HAZARDOUS WASTE	0.1	798
OTHER WASTES	0.2	871
TOTALS	100.0	541,514

NOTE: This table does not include recyclables that are segregated from the MSW stream for recycling by commericial and business establishments. Therefore, the data in this table does not provide a complete account of recycling activities in Seattle. The Utility reports that an additional 195,300 tons of recyclables were collected through private activities. (SWU "Summary of Recycling Program Impacts," April 21, 1989)

FIGURE 3-1: WASTE FLOW AND RESOURCE RECOVERY DIAGRAM SEATTLE, WASHINGTON (FY92)



respective service areas. Collection of bulky waste is performed on a "call in" basis.[9] The Utility reported that about 3,340 tons of white goods were collected by the two collection companies together in FY 1992.[10]

An estimated 97,276 tons of self-hauled garbage were processed through the City's transfer stations. Self-hauled garbage was delivered to the transfer stations by homeowners, businesses, or haulers not under contract to the Utility. The quantity of self-hauled garbage delivered to the transfer stations was calculated by subtracting the 142,154 tons (i.e., 96,679 plus 45,475) of residential garbage collected by the two collection companies and the 194,338 tons of commercial garbage delivered to the railhead from the total of 433,768 tons of garbage sent to the Columbia Ridge Landfill (i.e., 97,276 equals 433,768 minus 142,154 minus 194,338).

Similarly, an estimated 11,129 tons of self-hauled yard waste was delivered to the transfer stations by commercial landscapers and/or residents as part of Seattle's Clean Green program. This amount was calculated by subtracting the 24,547 tons collected by General Disposal and delivered to the South Transfer Station from the total of 35,676 tons of yard waste delivered to the Cedar Grove composting facility by the Utility (i.e., 11,129 equals 35,676 minus 24,547).[11]

A total of 433,768 tons of garbage and 45,919 tons of yard waste were collected in Seattle and processed through or disposed of in the Utility's IMSWM System. Of this amount 275,106 tons, or about 57 percent, were transferred through the two City transfer stations.

White goods, wood waste, and self-hauled recyclables were also processed through the transfer stations, resulting in a total of about 284,000 tons of waste, exclusive of HHW, being handled at the City's transfer stations in FY 1992. Thus, approximately 53 percent of the 541,514 tons of waste that were processed through or disposed of in the Utility's IMSWM System went through the City's transfer stations. The balance, about 257,000 tons of waste, was direct-hauled to various facilities, including the Utility's HHW drop-off facility, the Union Pacific Railhead, the Cedar Grove composting facility, the Recycle America MRF, or the Recycle Seattle (Rabanco) MRF.

3.2 Recyclables Collection and Processing

The Utility contracted with two firms for the collection and processing of residential recyclables. Each contractor collected source-separated newsprint, glass containers, ferrous and non-ferrous cans, mixed wastepaper and PET and HDPE plastics from residences with four and fewer

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[9] "Solid Waste and Yard Waste Collection Contract," City of Seattle and U.S. Disposal, January 1, 1989 - March 31, 1996, Section 185, page 12, and "Solid Waste and Yard Waste Collection Contract," City of Seattle and General Disposal Corp., January 1, 1989 - March 31, 1996, Section 185, page 14.

[10] Communication between J. Bagby, Seattle Solid Waste Utility, and A. Cohen, CSI Resource Systems, Incorporated, June 29, 1993.

[11] Yard waste collected by U.S. Disposal was delivered to Cedar Grove by U.S. Disposal or its parent company, Rabanco.

dwelling units.[12,13]

Recycle America and Recycle Seattle collected 25,475 and 22,812 tons of recyclables during FY 1992, respectively. The recyclables collected on behalf of the Utility were delivered to and processed at each firm's MRF. Neither MRF is dedicated exclusively to processing these curbside-collected recyclables.

The 48,287 tons recyclables collected by Recycle America and Recycle Seattle represent 85 percent of the recyclables collected and processed pursuant to Utility-sponsored recycling programs. The balance of 8,531 tons of recyclables was collected as part of the Utility's apartment recycling and drop-off center programs, including the drop off-program at each City transfer station.

Estimates of the composition of the materials collected in the north and south sectors, as provided in Figure 3-2, were made by the Utility. Actual measurements of the tonnages of each material collected from Seattle's curbside program are not available because these materials were commingled with other materials at the MRFs.

3.3 Yard Waste Composting

In FY 1992, 45,919 tons of yard waste were delivered by or on behalf of the Utility to the Cedar Grove composting facility. About 78 percent of this tonnage was hauled to Cedar Grove by the Utility from its transfer stations. The balance was either delivered directly by U.S. Disposal or transferred through Rabanco's transfer station, which is located adjacent to Recycle Seattle's MRF. (Both U.S. Disposal and Recycle Seattle are subsidiaries of Rabanco.) The Utility also encourages backyard composting by residents, but no attempt was made in this analysis to estimate the quantities diverted by that practice.

3.4 Household Hazardous Waste

A reported 798 tons of HHW were collected, processed, and disposed of by the Utility in FY 1992. Of this amount, 543 tons, or 68 percent, were waste oil.

3.5 Rail-Haul and Landfill

Under contract to the Utility, Washington Waste Systems, Inc. rail-hauled 433,768 tons of garbage to the Columbia Ridge Landfill for disposal in FY 1992.[14] Of this amount, 194,338

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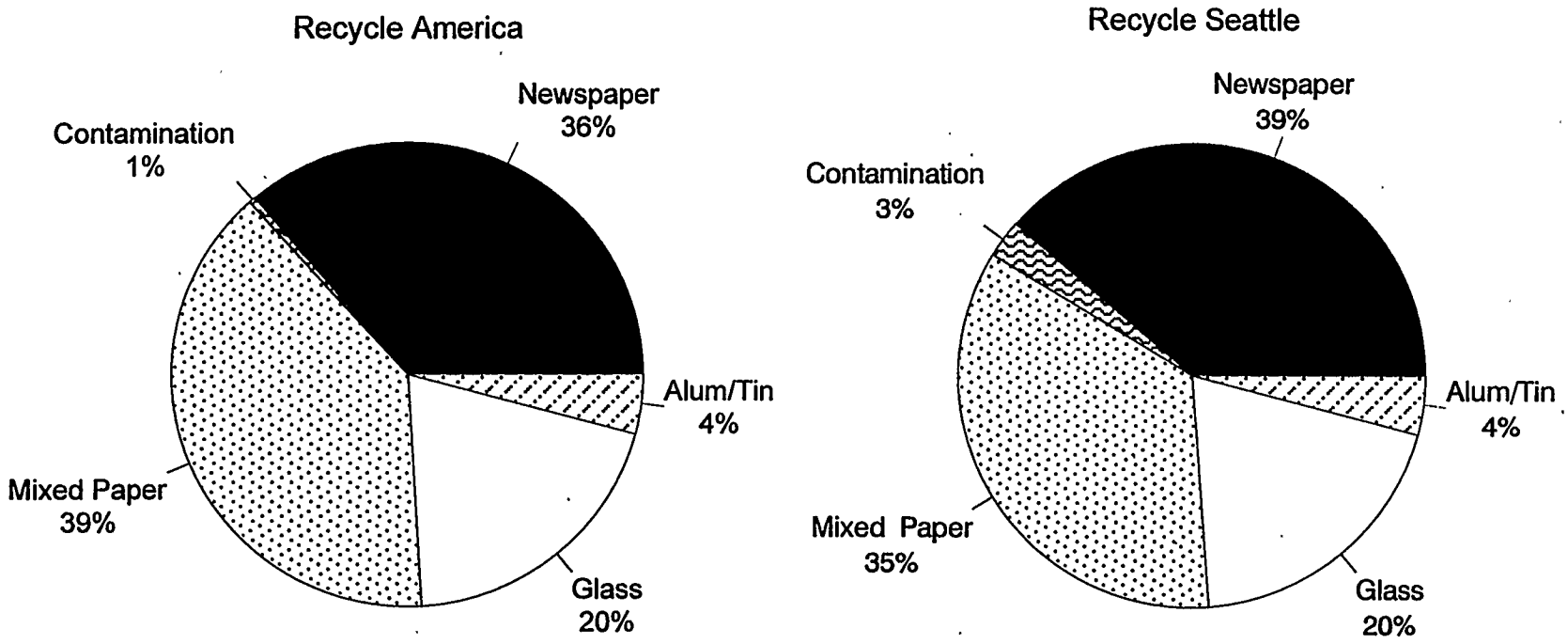
[12] "The City of Seattle Home Collection of Source Separated Recyclable Materials Contract," City of Seattle and Recycle America, October 21, 1987 - December 31, 1992, page 1, and "The City of Seattle Home Collection of Source Separated Recyclable Materials Contract," City of Seattle and Recycle Seattle, January 1988 - February 28, 1993, pages 1 and 2.

[13] Plastics were not included in the original contracts but were added to the program prior to FY 92.

[14] Monthly Invoices, services provided from January 1, 1992 through December 31, 1992.

FIGURE 3-2: ESTIMATED MATERIALS COLLECTED IN FY 1992

North and South Sectors
(Percent by Weight)



Source: "Seattle's Curbside Recycling Program," Road to Recovery, page 3.

tons, or about 45 percent, were delivered directly to the railhead by sources other than the Utility. This garbage was collected and transferred to the railhead by private firms on their own behalf or under contract to business establishments.

The City enacted a flow control ordinance whereby all garbage generated in the City that is not delivered to a City transfer station must be placed in sealed shipping containers and delivered to the railhead, where it enters the Utility's IMSWM System.

3.6 Markets for Recovered Materials

There are strong local markets for several recovered materials in Seattle. Within the City there is a major detinning plant, a scrap steel mill, and a large glass container manufacturer. Three pulp mills in the state are adding de-inking capacity for newsprint. Aluminum generally was shipped to smelters in the southeastern U.S., while mixed paper and some plastics were shipped from the Port of Seattle to Pacific Rim markets. In general, the market for recovered plastics was weak in FY 1992.

About 54,180 tons of recovered recyclable materials were sold to various outlets during FY 1992. The State of Washington conducted a survey to track the remanufacturing or distribution points for recovered materials in King and Snohomish counties.[15] CSI contacted a number of these market outlets to determine: (1) the end use of the material; (2) the distance travelled from the MRF to the processing or manufacturing destination; (3) the mode of transport; and (4) the product specifications for the recovered recyclables. Because the State's survey was not specific, Seattle and both recycling firms did not, for competitive reasons, wish to disclose markets, the survey results are only reflective of the situation in Seattle.

Table 3-2 summarizes the customer responses to this survey, by commodity. A summary of the findings follows.

Recovered aluminum was marketed to, among others, Reynolds Aluminum. The aluminum was typically transported via trailer trucks carrying an average load of six to seven tons to the Reynolds Aluminum facility in Kent, Washington (20 miles from the City). The aluminum (foil mix and cans) was shredded and loaded into containers for transport via rail from Kent to Memphis, Tennessee, and via trailers from Memphis to smelters in Sheffield, Alabama. The aluminum was used in the manufacture of secondary can sheet.

Recovered glass was marketed locally to Fibers International and the City of Seattle. Fibers International brokered the mixed glass to Ball Incon of Bellevue, Washington, and the green glass to various outlets in California. The mixed glass was transported by trailer trucks to the Ball Incon jar and bottle manufacturing facility.

The number of outlets for recovered paper varied with the grade of the paper. Some of the firms that purchased paper in King and Snohomish counties in FY 1992 were American Chug Nam, Consolidated Fibers, Daishowa America, Georgia Pacific, Ideal Paper, Jefferson Smurfit, Kanematsu USA, North Coast Fibers, Potential Industries, Scott Paper, Tzeng Long,

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[15] State of Washington, "1992 Washington State Recycling Survey Form."

TABLE 3-2: MARKETS FOR SELECTED RECOVERED MATERIALS SOLD IN FY 1992

RECOVERED MATERIALS	TONNAGE	TONS REJECTED	DISTANCE TO VENDOR (miles)	MODE OF TRANSPORT	REMANUFACTURE REUSE	COMMENTS
ALUMINUM						
	635	None	20	Transfer Trailer	Can Sheet	Markets to local smelters
Subtotal	635					
GLASS						
Aggregate	4,533	None	3	Transfer Trailer	Bottles/Jars	
Green				Recycle America:		
				Transfer Trailer (6-9 tons)		
				Roll Off Containers		
				Recycle Seattle:		
				Transfer Trailer (10-12 tons)		
				End Dump		
Subtotal	4,533					
PAPER						
Corrugated	190	None	485	Transfer Trailer (23 tons)	Corrugated Medium	Also processes mixed paper, clippings
	62	None	320	Transfer Trailer (> 23 tons)	Linerboard	
Mixed	29	None	Pacific Rim-Indonesia,	Shipped Via Bales in Containers	Boxboard	
	1,854		China, Taiwan			
	610		India, China	Transfer Trailer (21 metric tons)	Boxboard	
News #8	4,291	Low %	205	Transfer Trailer (23 tons)	Newsprint	
	3,515		195			
		None	70	Transfer Trailer (30 tons)	Telephone Directory Stock	
Paper Phone Books						
Subtotal	10,551					
PLASTICS						
HDPE	172	None	Pacific Rim	Transfer Trailer (20 tons)	Pellets Added To Virgin Materials	
	21	None	Pacific Rim	Transfer Trailer (20 tons)	Gas Cans, Toys, Low Level Plastics	
Plastic PET						
Subtotal	193					
TIN CANS						
	997			Transfer Trailer		Detinning facility
Subtotal	997					
TOTAL	16,909					

Weyerhauser, and Yao Yang. From the CSI telephone survey, it was determined that:

(1) A portion of the recovered corrugated paper purchased in Seattle was transported via transfer trailer trucks to remanufacturing facilities that are 320 and 485 miles from Seattle. This corrugated paper was remanufactured into corrugated medium and linerboard.

(2) A portion of the mixed paper recovered in Seattle was baled, containerized, and shipped through the Port of Seattle to Pacific Rim destinations, such as Indonesia, China, Taiwan, and India. This mixed paper was typically used in the manufacture of boxboard.

(3) A portion of the recovered newspaper purchased in Seattle was transported via transfer trailer trucks to remanufacturing facilities that were 70 to 205 miles from Seattle. The recovered newspaper, along with recovered magazines and telephone books was remanufactured into newsprint and telephone directory paper.

Recovered PET and HDPE was marketed to Benison International Trade, Kingman Products, and O'Neill & Company. The sorted and baled HDPE was typically shipped via container from the Port of Seattle to Pacific Rim pelletizer facilities. The commodity was used as low-end resin to supplement virgin materials in the manufacture of hard plastic items such as gas cans and toys.

The recovered tin cans were marketed to Proler International. The cans were transported via trailer truck to Proler's detinning facility in Seattle.

In addition to the 54,183 tons of material that were recovered and sold, an estimated 3,360 tons of mixed cullet was recovered and stockpiled by Recycle America for potential future use.

The compost produced by the Cedar Grove Composting Facility operations was sold in bulk at the Cedar Grove facility and at area nurseries. In addition, other composting facilities have purchased the facility's product for use in their compost blends. In February 1991, Cedar Grove introduced a bagged "plant soil," which is a blend of 75-percent compost and 25-percent fine barkdust. This plant soil is now available in King County retail chains, nurseries, and garden centers. In 1994, the Utility began purchasing Cedar Grove's compost for use as final cover for landfill closure projects.

4. Cost of MSW Management in Seattle

The cost of MSW management in Seattle includes collection, transfer, haul, processing, combustion, disposal, and the marketing of recovered materials.

Section 4.1 of this report presents the salient results of the analyses performed for this section of the study. Section 4.2 defines that portion of the waste stream for which collection costs are known, i.e., "Analyzed MSW." Section 4.3 presents both the total cost incurred by the Utility for the management of MSW in FY 1992, and the total cost of managing the approximately 232,000 tons of Analyzed MSW. In Sections 4.4 and 4.5, these costs are allocated by functional area and type of MSW [i.e., garbage, yard waste, recyclables (including white goods), and HHW), respectively. Section 4.6 presents the marginal and program incremental costs of the Utility's curbside recycling and yard waste programs within the City.

4.1 Summary of Results

Of the approximately 541,400 tons of MSW managed within the City, about 232,000 tons were analyzed (Analyzed MSW) to determine the cost of Seattle's IMSWM System. Because the collection costs for the approximately 309,000 tons of self-hauled MSW are not known, this tonnage is excluded from the analysis, as is the tonnage of C&D waste (which is not considered MSW).

4.1.1 Overall Program Costs

The total FY 1992 cost for the Utility to manage the approximately 232,000 tons of Analyzed MSW was about $30.2 million, or about $130 per ton. This total cost breaks down to, in rounded numbers:

CATEGORY	TONNAGE	TOTAL COST	TOTAL COST PER TON
Garbage	142,000	$21.6 million	$152
Recyclables	54,600 (51,100 recycled)	$ 4.5 million	$ 88 (per ton recycled)
Yard Waste	34,790 (34,440 sold)	$ 4.1 million	$119 (per ton sold)
TOTAL/AVERAGE	232,000	$30.2 million	$130

The cost of managing the 798 tons of HHW processed in FY 1992, which was analyzed separately because collection costs are not known, was about $1.4 million, or over $1,700 per ton.

As shown in Figure 4-1, collection and processing account for over 50 percent of the total cost of the Seattle System, while transfer, haul (including railhaul), and disposal account for over 30 percent of the cost. Figure 4-2 shows the allocation of costs to each of the key functional areas (e.g., collection/processing, transfer, haul, etc.) for each of the program areas. Note that for recyclables and yard waste, collection/processing accounts for 70 percent or more of the costs

FIGURE 4-1 ALLOCATION OF TOTAL COSTS FOR IMSWM SYSTEM IN FY92

Allocation by Functional Area
(Cost to Manage 232,000 tons of Analyzed MSW)

TOTAL COST IS $30,230,000

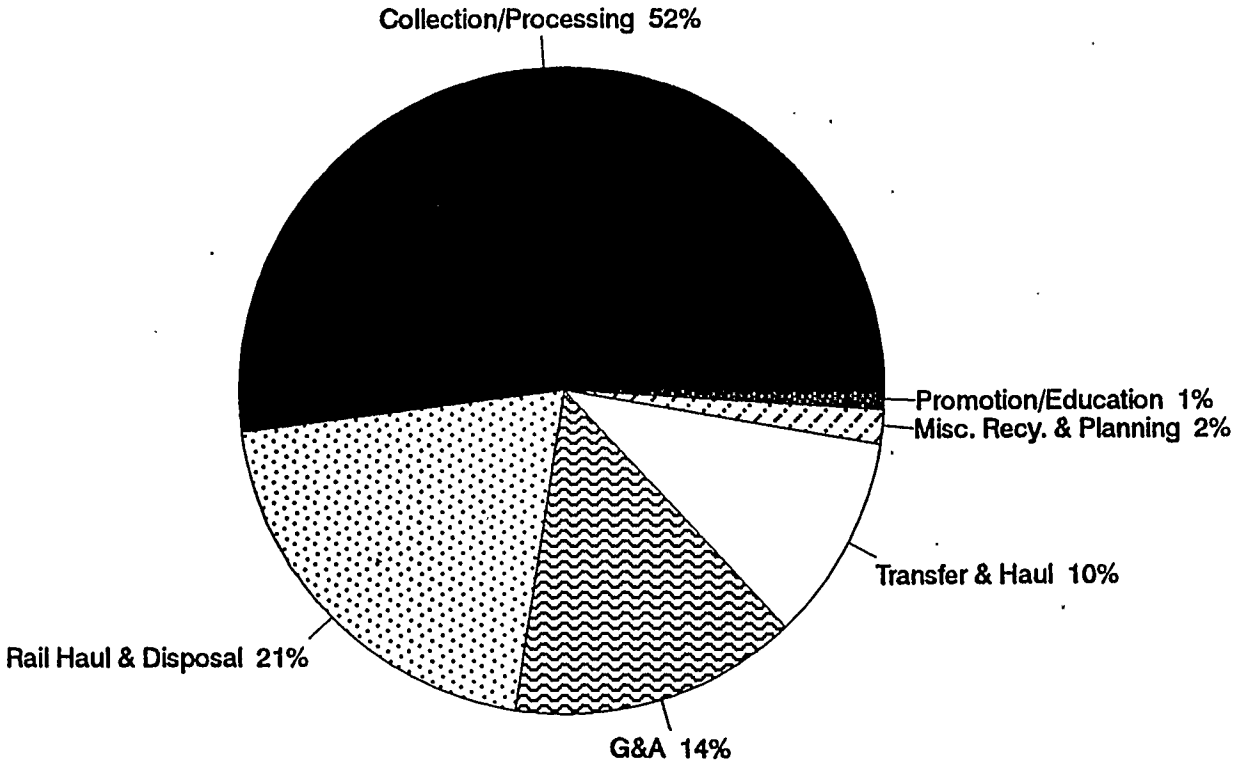
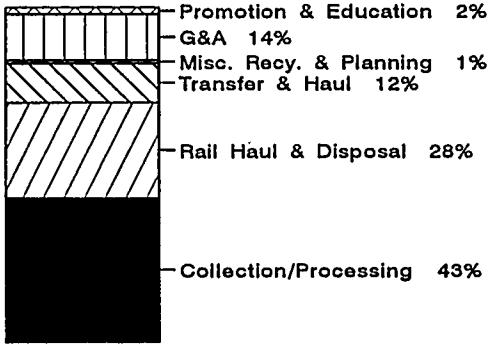


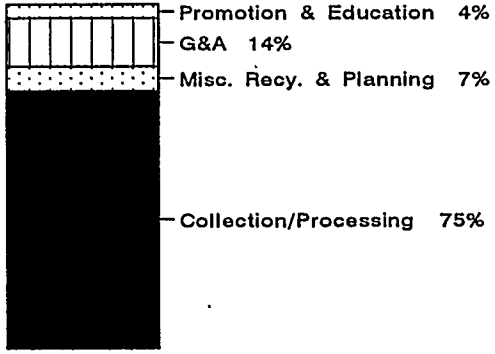
FIGURE 4-2: ALLOCATION OF COSTS TO MANAGE MSW IN SEATTLE, WA

Allocation by Functional Area

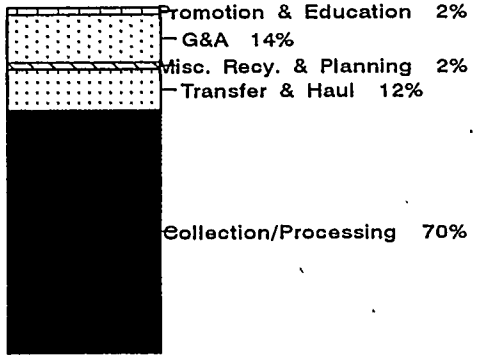
RESIDENTIAL GARBAGE



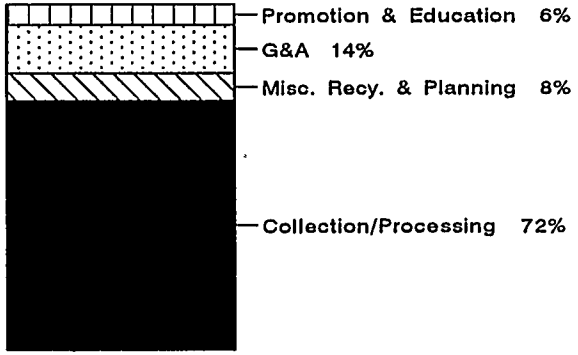
RECYCLABLES



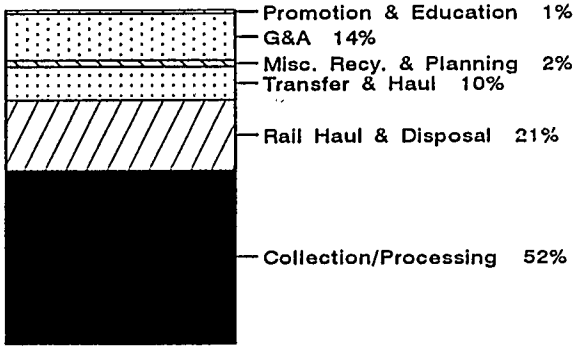
YARD WASTE



HHW



TOTAL MSW



to manage those components of the waste stream.

4.1.2 Program Incremental Costs

The incremental cost for each of the resource recovery programs, i.e., the cost (or savings) associated with adding the program to the IMSWM System, is the difference between the cost of managing all the MSW with and without that program. The Program Incremental Cost (or Savings) is, therefore, an appropriate measure of the impact of any particular program on the cost of managing MSW. The FY 1992 Program Incremental Cost (or Savings) of each of the City's resource recovery programs was, in rounded numbers:

PROGRAM	TONNAGE	INCREMENTAL COST (SAVINGS)	
		Dollars	$ Per Ton
Curbside Recycling	48,200	($17,200)	--
Yard Waste Composting	45,500	$568,000	$13

In addition to the incremental cost or savings that can be attributed to each of the resource recovery programs, each of them contributes materials to the economy and reduces the utilization of available landfill space. These attributes are shown in Table 4-1.

4.2 Apportionment of Waste Stream

Aside from the reporting of the total cost incurred by the Utility in FY 1992, only a portion of the waste stream described in Section 3 (i.e., Analyzed MSW) is included in the economic analyses presented in this Section. A detailed discussion of the methodology used to determine this cost and the data used to conduct the associated economic analyses are presented in Appendix C.

The reasons for limiting the tonnage included in the analysis are: (1) to limit the study to the management of MSW; and (2) to include only that portion of the MSW stream for which the total cost of collecting, transferring, hauling, processing, marketing, and disposing is known. Failure to limit the economic analysis to the tonnage and costs associated with Analyzed MSW would bias the results and could lead to misleading conclusions.

The Analyzed MSW excludes C&D waste (which is not considered a component of MSW) that is processed and/or disposed of by the Utility's IMSWM System; thus, both the costs and quantity (approximately 871 tons) of wood waste are excluded from the analysis. Because the cost of collecting and hauling waste that is self-hauled, including recyclables and HHW that were brought to drop-off sites, is unknown, the approximately 309,000 tons of FY 1992 self-hauled waste have also been excluded from the cost analyses. Approximately 63 percent of the waste excluded from the analysis comprises the 194,338 tons of commercial MSW that were self-hauled to the Union Pacific railhead in FY 1992.

Table 4-2 shows that portion of the waste stream for which collection costs are known and that therefore is included in the cost analyses. This portion of the waste stream, referred to in the

TABLE 4-1: INCREMENTAL COST AND EFFECTIVENESS OF RESOURCE RECOVERY PROGRAMS IN SEATTLE, WA (FY 1992)

RESOURCE RECOVERY PROGRAM	TONS MANAGED	TOTAL INCREMENTAL COST	AVERAGE INCREMENTAL COST	EFFECTIVENESS	
				MATERIALS RECOVERED	LANDFILL VOLUME REDUCTION
Curbside Recycling	48,236	($17,200)	($0)/Ton ($0)/CuYd	19,200 Tons Newspaper	44,300 Cubic Yards
				19,100 Tons Mixed Pape	43,800 Cubic Yards
				7,860 Tons of Glass	10,000 Cubic Yards
				2,100 Tons Metal/Plastic	5,260 Cubic Yards
				48,200 Total	103,000 Cubic Yards
Yard Waste Compostin	45,460	$568,000	$13/Ton $3/CuYd	28,800 Tons Compost	209,000 Cubic Yards

TABLE 4-2: PORTION OF WASTE STREAM FOR WHICH COLLECTION COSTS ARE ESTIMATED

WASTE TYPE	TOTAL COLLECTED (tons)	ANALYZED MSW (tons)
GARBAGE		
North/General Disposal	96,679	96,679
South/U.S. Disposal	45,475	45,475
Self Haul to Transfer Stations	97,276	0
Self Haul to Railhead	194,338	0
SUBTOTAL GARBAGE	433,768	142,154
YARD WASTE		
North/General Waste	24,547	24,547
South/U.S. Disposal	10,243	10,243
Self Haul to Transfer Stations	11,129	
SUBTOTAL YARD WASTE	45,919	34,790
RECYCLABLES		
North/Recycle America	25,475	25,475
South/Recycle Seattle	22,812	22,812
Apartments	2,973	2,973
Self Haul to Transfer Stations	5,141	
Other (e.g., plastic drop off)	417	
SUBTOTAL RECYCLABLES	56,818	51,260
HOUSEHOLD HAZARDOUS WASTE	255	
OTHER WASTES		
Wood	871	
Construction & Demolition		
Oil	543	
White Goods	3,340	3,340
Other		
SUBTOTAL OTHER WASTES	4,754	3,340
TOTALS	541,514	231,544

table as Analyzed MSW, represents about 43 percent of the total waste stream. Analyzed MSW consists of: (1) all residential garbage collected in the City; (2) all residential yard waste collected in the City; (3) all recyclables collected from residential buildings with four or fewer dwelling units; (4) a portion of recyclables collected from apartment buildings with five or more dwelling units; and (5) collected white goods. Collection of all the Analyzed MSW is performed by private firms under contract with the Utility.

When a portion of the MSW stream is excluded from an analysis performed in this section because its collection costs are unknown or because it is not considered MSW, the associated transfer, haul, processing, marketing, and/or disposal costs are also excluded from the analysis. Consequently, the cost comparisons among types of MSW are valid and include all the costs required to manage the Analyzed MSW stream from the time it is picked up at the curb until it is sold, re-used, or disposed of in the landfill.

4.3 Total Costs of MSW Management

The Utility's total cost of collecting, transferring, hauling, processing, marketing recovered materials, and disposing of the approximately 232,000 tons of Analyzed MSW in FY 1992 was approximately $30.2 million. This represents an Average Cost of $131 per ton.[16]

This cost was calculated by determining the total audited expenses incurred by the Utility in FY 1992; adjusting these costs as appropriate to satisfy the requirements of this study; and allocating costs to determine that portion of the adjusted costs attributed to the management of Analyzed MSW.

4.3.1 Utility Reported Costs

The Utility is a public utility of the City of Seattle and is operated and administered by the City's Director of Engineering. As a public utility it must establish rates for its services that cover all its costs. These costs must in turn include all expenditures required to meet the Utility's obligations, including the costs of services provided to the Utility by other City departments and agencies. "The Utility is charged for these [City] services and additionally pays a business and occupancy tax to the City's General Fund."[17] Therefore, except for some collection costs incurred by private firms and individuals, the reported Utility costs represent a complete accounting of the costs it incurred to manage the 541,000 tons of waste collected, transferred, hauled, processed, marketed, and/or disposed of in its IMSWM System.

The reported Utility revenues and expenses for FY 1992 are provided in Table 4-3.[18] In FY

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[16] These costs are exclusive of the $3.7 million in State and City Business and Occupancy taxes charged to the ratepayers by the Utility.

[17] Arthur Anderson, "City of Seattle-Solid Waste Utility, Financial Statements as of December 31, 1992 and 1991 Together With Auditors' Report," Notes to Financial Statements, page 1.

[18] SWU, "Solid Waste Utility Income Statement," Final Audit, May 7, 1993.

TABLE 4-3: STATEMENT OF REVENUES AND EXPENSES
Year Ending December 31, 1992

	AS REPORTED	REPORTED COSTS	ADJUSTED COSTS
OPERATING REVENUES			
Residential Collection Services	$39,852,046		
Disposal Serices	15,978,473		
Commercial Surtax	2,609,056		
Residential Surtax	2,608,352		
Resource Recovery	79,459		
Miscellaneous	22,293		
	61,149,679	0	0
OPERATING EXPENSES			
Private Garbage Collection	9,490,341	$9,490,341	$9,466,012
Transfer Stations	4,060,081	4,060,081	4,060,081
Transport & Hauling	976,988	976,988	976,988
Railhaul & Disposal	19,074,044	19,074,044	19,074,044
Landfill Closure	1,245,263	1,245,263	1,245,263
Recycling/Special Wastes	8,520,458	8,520,458	8,484,745
Household Hazardous Waste	1,353,624	1,353,624	1,302,624
Litter Control	1,966,959	1,966,959	1,966,959
Customer Billing and Collection	4,593,799	4,593,799	4,593,799
General & Adinistrative	3,810,307	3,810,307	3,810,307
Depreciation and Amortization	1,580,891	1,580,891	
Annual Capital Cost			2,373,767
Amortization of Landfill Closure	3,179,009	3,179,009	3,179,009
Taxes, Including City Occupation	8,233,324	8,233,324	0
	68,085,088	68,085,088	60,533,598
OPERATING INCOME (EXPENSES)	(6,935,409)	(68,085,088)	(60,533,598)
NON-OPERATING REVENUE (EXPENSES)			
Interest on Investments	1,459,002		
Gain of Sale of Assets	41,228		
Operating Grants	656,298		
Interest Expense and amortization	(3,750,156)	(3,750,156)	(3,750,156)
Other	63,069		
	(1,530,559)	(3,750,156)	(3,750,156)
NET INCOME (EXPENSES)	($8,465,968)	($71,835,244)	($64,283,754)

SOURCES: SWU, "Solid Waste Utility Income Statement," Final Audit, May 7, 1993, and "Financial Statements as of December 31, 1992 and 1991 Together with Auditors' Report.

1992 the Utility had Operating Revenues of $61.1 million, Operating Expenses of $68.1 million, and Other Non-Operating Expenses of just over $1.5 million, resulting in a Net Expense of almost $8.5 million.[19]

The largest sources of Operating Revenues (i.e., about 91 percent) were the fees charged to residences for the collection and disposal of garbage and the fees charged to commercial customers for the use of the rail-haul and landfill subsystem. About 8.5 percent of the Operating Revenues were commercial and residential surtaxes assessed to help defray the costs of the closure of the Kent-Highlands and Midway landfills.[20] Non-Operating Revenues consisted of interest income, grants, the sale of assets, and other miscellaneous income. The interest income is primarily derived from invested revenues from the pre-payment of fees. Because the purpose of this analysis is to determine the costs of the IMSWM System and not the prices and fees charged by the Utility, these revenues are not included in the analysis.

The costs incurred by the Utility for the collection, processing, and marketing of recyclable materials are net of any revenues received by the contractors from the sale of the recovered materials. Revenues received from the sale of self-hauled recyclables (i.e., those delivered to the transfer stations or other drop-off sites) are not included in this analysis, so as to be consistent with the exclusion of the costs of transferring and marketing these materials.

Based on the treatment of revenues and expenses in this analysis, the reported cost to the Utility for all waste management activities in FY 1992 was about $71.8 million, as was shown in Table 4-3.

4.3.2 Adjustments to the Utility's Reported Costs

For the purpose of this analysis, six adjustments were made to the reported costs. In addition, the reported non-landfill-closure depreciation and amortization cost has been replaced by an annualized capital cost, based on the assets purchase price, expected useful life of the Utility's capital assets, and the cost of capital.[21]

To determine whether any adjustments were required, the unaudited detailed expenditures of the Utility were analyzed to determine their consistency with the final audited summary expenses that were shown in Table 4-3.[22,23] The sum of the detailed expenditures was $996 more than the

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[19] The Utility operates as an independent financial entity that must be self-supporting, i.e., it can receive no subsidies from general funds or tax revenues. As such, any annual operating deficits must be made up in subsequent years.

[20] The SWU stopped disposing MSW in Midway in 1983 and Kent-Highland in 1986. Both landfills have been declared federal superfund sites. In 1987 the estimated closure cost for both landfills was $77 million.

[21] See Appendix D for a detailed discussion of the approach used in this analysis to calculate capital costs.

[22] SWU, "Year End Expense Distribution," Computer Printout.

final audited figures; therefore, the detailed expenditures served as the basis for the analysis.[24]

Among the detailed expenses was a $51,000 cost for "Haller Lake Sidewalks/Curbs." This expense was part of the development of an HHW collection program in the northern part of the City. During the development of the analysis, the Utility's director of rates advised that this cost should have been capitalized rather than expensed.[25] Therefore, the HHW cost was reduced by this $51,000, and the capital cost was increased by $5,600 to account for this capital expense.[26] (See the last column of Table 4-3 for these adjustments.)

Similarly, the $80,748 "Other Recycling" and $20,690 "SW Services" planning activities charged to Recycling/Special Waste were expensed rather than capitalized. On the other hand, approximately $2.1 million of planning activities were expensed rather than capitalized in prior years.[27] For this analysis, these planning efforts are treated as capital expenses; therefore, the Recycling/Special Waste cost was reduced by $101,438 (i.e., $80,748 plus $20,690) and the capital cost was increased by $313,200.[28] (The last column of Table 4-3 reflects these adjustments).

Because a large portion of the Utility's expenses are for contract services, a review of the monthly invoices for U.S. Disposal, General Disposal, Recycle America, Recycle Seattle, and Washington Waste Systems, Inc. was also performed.

The Utility's reported cost for contracted private collection in FY 1992 was $9.49 million. Ninety-nine percent of this cost comprised payments made to General Disposal and U.S. Disposal for the collection of residential garbage. Review of the invoices submitted by each firm revealed that $24,329 of the payments made to U.S. Disposal in FY 1992 were for services provided in FY 91. Specifically, U.S. Disposal was paid $13,941 for "Yard Waste Publicity for Year 1991," $10,000 for "Promotion & Education for Year 1991," and $388 for "1990 CPI Adjustment."[29]

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[23] These expenditures can be found in Tables B.2 through B.14 in Appendix B.

[24] A credit of $996 was arbitrarily assigned to "Misc. Recycling Expenses" to account for this difference. See Table B.9 of Appendix B.

[25] Telephone conversation between S. Viney, Director of Rates, SWU and A. Cohen, June 21, 1993.

[26] The $5,600 was calculated assuming a cost of capital of 7 percent and an assumed useful life of the asset of 15 years.

[27] Discussion with Nick Pealy, Director, Strategic Planning, Finance, and Information Systems, SWU, February 1994.

[28] The $313,200 was calculated assuming a cost of capital of 7 percent and an assumed useful life of the planning effort of 10 years.

[29] "December 1992 Payment Authorization Summary," Solid Waste Utility Contract with U.S. Disposal for Waste Collection, page 3.

Because these specific charges were also included for 1992, the total cost for "Private Garbage Collection" reported by the Utility was reduced by $24,329 (i.e., reduced from $9,490,341 to $9,466,012).

The Utility's reported $8,520,458 of "Recycling/Special Wastes" expenses includes the cost of collecting and processing yard waste and recyclables. This amount included payments to U.S. Disposal totalling $1,397,836.[30] A review of U.S. Disposal's monthly invoices showed that this amount reflected billings from January 1, 1992, through November 30, 1992. It did not include the December 1992 billing of $65,725.[31] Because the Utility uses an accrual method of accounting and all other expenditures reflect billings from January 1, 1992, through December 31, 1992, the omitted December charge was added to the reported Recycling/Special Wastes cost. The resulting "Recycling/Special Wastes" cost of $8,484,745 reflects this adjustment along with the reduction of planning expenses discussed previously.

As a public utility, the Solid Waste Utility pays the State of Washington and the City of Seattle business and occupancy taxes. In FY 1992, the Utility paid about $8.2 million in such taxes. Because the revenues raised by these taxes are viewed as general revenues for the State and City and are not dedicated to the management of MSW, they reflect transfer payments rather than costs. As a result, these taxes are not included in the Adjusted Cost shown in Table 4-3.[32]

A capital expense is the purchase of an asset or service with a useful life of more than one year. Capital expenses are often reported as capital outlays (i.e., the actual payment made during the year) or are depreciated/amortized; for example, the capital outlay is divided by the useful life of the asset. The Utility depreciates plant and equipment using "a straight-line method over estimated useful lives as follows: transfer station, scalehouses and related improvements - 5 to 33 years; [and] machinery and equipment - 7 to 15 years. It is the Utility's policy not to record depreciation in the year of acquisition and to record a full year's depreciation charge in the year of disposition."[33] Capital assets may be purchased with cash, be financed, or be acquired by a combination of both cash and financing. If financed, interest payments on borrowed funds are reported as interest expenses.

Although either a capital outlay or depreciation/amortization approach is appropriate for generating the financial statements of non-profit organizations, neither is appropriate for estimating economic costs. The reporting of capital outlays does not recognize that the capital asset will be used over several years; therefore, its costs should be spread over several years.

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[30] SWU, "Year End Expense Distribution," Computer Printout, page 10.

[31] "Payment Authority - U.S. Disposal Yard Waste Collection and Yard Waste Processing," November 1992 and December 1992.

[32] Although these taxes are not included in the cost assessment, the Utility does pass them on to the ratepayers. The cost presented in this section can be increased by 12.8 percent to estimate the costs, including these taxes paid by the ratepayers.

[33] Arthur Anderson, "City of Seattle-Solid Waste Utility - Financial Statements as of December 31, 1992 and 1991 Together With Auditors' Report," page 2.

The depreciation and amortization plus interest approach does not adequately account for assets purchased with cash, i.e., it does not account for the time value of money. On the other hand, if a capital asset is financed, the interest payment in any year is highly dependent on the age of the debt and the repayment schedule, i.e., interest payments may vary significantly over the life of an asset.

The approach used in this analysis is to "annualize" capital expenses over the useful life of the assets assuming a 7-percent cost of capital. The cost of capital reflects the value of invested funds to the Utility. If the Utility pays cash for an asset, this approach assumes an additional imputed annual cost of 7 percent (i.e., the cost of capital) for the investment in the asset. If the asset is financed with borrowed funds, the analysis substitutes an imputed cost of 7 percent for the actual interest expenses. Using this approach, the capital cost is the same regardless of the sources of funds, the repayment schedule of borrowed funds, or the age of the asset during its useful life. This approach is similar to methods used by private firms when making investment and borrowing decisions.[34]

The Utility reported non-landfill-closure Depreciation and Amortization Expenses of $1,580,891 in FY 1992. A detailed buildup of this depreciation expense was not made available for use in this analysis. Instead, information was obtained from the Utility on capital outlays made in 1992, and the capital costs of the transfer station modifications to accommodate the rail-haul system, transfer trailers and tractors, and recycling equipment.[35,36] The capital costs shown in Table B.12 of Appendix B were estimated using this information and the procedure defined in Appendix D.

Depreciating the itemized assets resulted in an estimated depreciation cost of $857,000, or 54 percent of the Utility's total reported depreciation expense. The capital cost of the balance of $724,000 was estimated by assuming an average useful life of 7 years.

The resulting capital cost estimate is $2,055,000. Adding to this the $5,600 capitalization of the Haller Lake Sidewalk/Curb and the $313,200 planning expenses result in a total capital cost of $2,373,800. This amount has been substituted for the $1,580,891 Depreciation and Amortization expense reported by the Utility.[37]

The combined effect of these adjustments was to decrease the FY 1992 costs of the Utility from $71,835,244 to $64,283,754. About $8.2 million of this difference is due to the treatment of taxes as transfer payments instead of costs. The combined effect of non-tax adjustments increased

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[34] Refer to Appendix D for a detailed discussion for determining capital costs.

[35] See Table B.10 of Appendix B.

[36] More detailed information was not sought because depreciation and amortization of non-landfill-closure costs is only 2.2 percent of the Utility's total reported cost in FY 92.

[37] No adjustment was made to the Amortization of Landfill Closure Cost reported by the SWU and the related bond interest expenses because these costs were eventually excluded from the analysis, making such adjustments unnecessary.

the FY 92 cost by only $515,000, or less than 1 percent. These adjustments also affect the allocated costs reported below.

4.3.3 Analyzed MSW Costs

Of the $64.3 million expended by the Utility in FY 1992, approximately $30.2 million, or 47 percent, is attributed to the collection, transfer, haul, processing, marketing of recovered materials, and disposal of the 232,000 tons of Analyzed MSW. The balance of $34.1 million was spent on self-hauled waste brought to the transfer stations, self-hauled waste brought to the railhead, closure of the Kent-Highland and Midway landfills, litter control, HHW management, waste reduction programs, and other miscellaneous activities.

The percent distribution of these costs is provided in Figure 4-3. Thirty percent of the Utility's total expenses is attributed to the transfer, rail-haul, processing, and/or disposal of self-hauled waste, while another 14 percent is attributed to the landfill closures. Expenditures for these activities represent about 83 percent of the $34.1 million spent on non-Analyzed MSW activities.

About $2.3 million, or about four percent, of the Utility's total expenditures during FY 1992 was spent on litter control. This cost includes direct costs of $1.97 million, and G&A allocations of $0.31 million. Litter is brought to the transfer stations and eventually rail-hauled to the Columbia Ridge Landfill for disposal. The actual quantity of litter collected by the Utility is unknown, but is included in the quantity of self-hauled waste delivered to the transfer stations. Because this litter/self-hauled waste tonnage is not included in the definition of Analyzed MSW, the cost of litter control activities has been excluded from the costs of managing Analyzed MSW.

The balance of the costs of non-Analyzed-MSW activities was for HHW, waste reduction, and miscellaneous expenses. The HHW cost amounted to $1.4 million, or about two percent of Utility's total FY 1992 expenses. The makeup of this cost is discussed in more detail in Section 4.4. Waste reduction activities expenses were $1.3 million: 48 percent was direct expenses, 26 percent was promotion and education expenses, and 26 percent was allocated G&A expenses. Miscellaneous expenses made up only 1 percent of the Utility's total. Ninety-eight percent of this miscellaneous expense was for programs related to the management of other wastes (e.g., wood, tires, infectious wastes, and C&D waste).

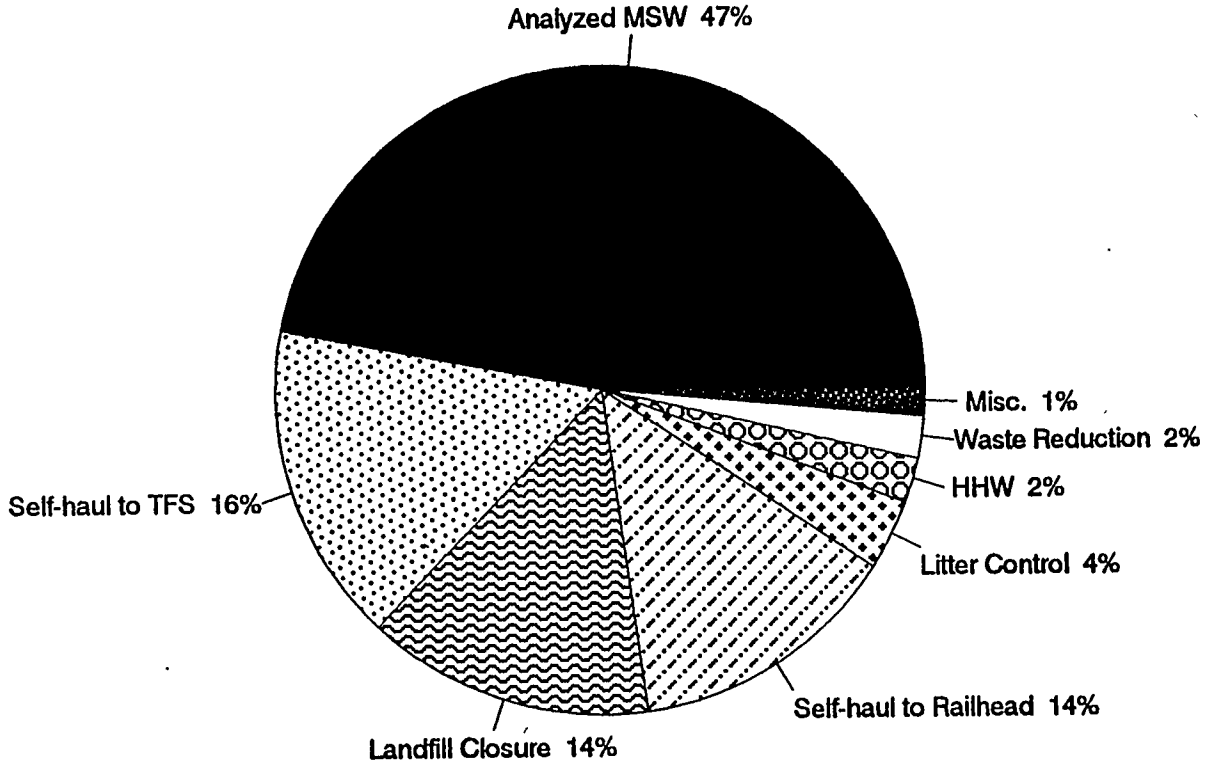
4.4 Allocation of Costs by Functional Area

Within this section, the Utility's $30.2 million cost for managing the 232,000 tons of FY 1992 Analyzed MSW is allocated among the functional areas of G&A, transfer and haul, collection/processing, rail-haul and disposal, miscellaneous recycling, and promotional and educational costs. To obtain these allocations, each detailed expenditure made by the Utility was categorized by functional area. Since most of the services provided by the Utility are through contracts with private firms, the firms' monthly invoices were reviewed to further categorize various charges. For example, U.S. Disposal, pursuant to its collection contract, conducted various promotional and educational activities. The $24,300 charge for these activities was subtracted from the collection costs reported by the Utility and allocated to Promotion &

FIGURE 4-3: TOTAL COST DISTRIBUTION OF SEATTLE SOLID WASTE UTILITY (FY92)

Analyzed MSW and Other Costs
(Cost to Manage 541,400 Tons of Waste)

TOTAL COST IS $64,280,000



Education Costs.[38] Figure 4-1 provided the resulting percentage allocation by functional area.

The Utility's $30.2 million cost for managing Analyzed MSW includes a $1.06 million capital cost.[39] To manage the Analyzed MSW, the Utility provides management, administrative, and planning services, and operates the two transfer stations and related vehicles. Therefore, this capital cost was allocated between the G&A and Transfer and Haul functions as follows: $395,800 to G&A expenses; $133,900 to Miscellaneous Recycling and Planning expenses, and about $531,000 (about 50 percent) to Transfer and Haul expenses. The portion of the capital costs attributed to G&A expenses is based on detailed data from other cities.[40] The G&A capital cost includes the cost of furniture, office equipment, and computer hardware and software. The Transfer and Haul capital cost includes the costs to modify the transfer stations with compactors and to purchase transfer vehicles.

As could be seen in Figure 4-1, about 62 percent of the Utility's FY 1992 cost of managing the 232,000 tons of Analyzed MSW is attributed to collection, transfer, haul, and processing of garbage, recyclables, and yard waste. Of this 62 percent, the Utility's transfer and haul operations account for 10 percent, and collection and processing account for the remaining 52 percent.

About 14 percent of the Utility's FY 1992 cost to manage Analyzed MSW was for G&A expenses. These costs include the costs of the Utility Director's office, financial services such as accounting and billing, contract services, purchasing, and personnel. The FY 1992 payments made by the Utility to Washington Waste Systems, Inc. to rail-haul and dispose of about 142,000 tons of the Analyzed MSW, and the costs to administer this contract, amounted to about $6.3 million, or about 21 percent of the Utility's total $30.2 million cost of managing Analyzed MSW. This $6.3 million is 33 percent of the $19.1 million total rail-haul and disposal cost, consistent with the fact that 33 percent of the tonnage rail-hauled and disposed of at the Columbia Ridge Landfill in FY 1992 was Analyzed MSW, i.e., garbage collected by U.S. Disposal and General Disposal. Of the $6.3 million, about $36,000, less than one percent, was spent on contract administration, and the balance was paid to Washington Waste Systems, Inc.

Miscellaneous recycling, planning, and promotional and educational expenses amounted to only three percent of the Utility's total $30.2 million cost of managing Analyzed MSW in FY 1992.

4.5 Allocation of Costs by Type of Waste

In the following subsections, the Utility's $30.2 million cost of managing the City's 231,544 tons of Analyzed MSW in FY 1992 is allocated to the cost of managing the 142,154 tons of garbage,

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[38] See Tables B.2 through B.14 for the functional areas to which each expenditure was allocated.

[39] The capital costs of the MRFs and composting facility were born by the private firms under contract to the SWU. These firms receive a return on these investments through the payments they receive for services provided to the SWU and other customers.

[40] See Table B.10 of Appendix B.

the 38,130 tons of recyclables (including the 3,340 tons of white goods), or the 51,260 tons of yard waste that together constitute the Analyzed MSW. Also provided, in subsection 4.5.4, are the allocated costs of managing the 798 tons of HHW. For each type of waste, allocated costs are also broken down by functional area.

The results presented are total allocated costs, i.e., G&A expenses are included in the allocation.[41] In general, the allocation process followed the following steps: (1) the portion of each expenditure that was applicable to the management of the 232,000 tons of Analyzed MSW was determined; (2) expenses that were dedicated to garbage, recyclables, yard waste; or HHW were identified (e.g., the garbage collection contract expenses were allocated to garbage); and (3) other expenses were allocated based on a number of factors such as tonnage and costs.

General and Administrative costs that were not specifically allocated to a type of waste in Step 2 above were allocated to each waste type in proportion to the dollar value allocated to each type of waste for all other non-tax costs. Consequently, the absolute value of the costs attributed to the management of garbage, recyclables, yard waste, and HHW reflect all costs, including G&A, and the relative value of these costs is unaffected by the allocation of the G&A expenses.

4.5.1 Cost of Managing Garbage

The Utility's FY 1992 cost of managing the approximately 142,000 tons of garbage collected, transferred, rail-hauled, and disposed of in the Utility's IMSWM System as a component of Analyzed MSW was approximately $21.6 million. The average cost of managing these 142,000 tons of garbage was $152 per ton.

The allocation by functional area of the $21.6 million spent on management of garbage is shown in Figure 4-4. Of this $21.6 million, approximately $9.4 million (44 percent) was spent on collection and $2.7 million (12 percent) on transfer and haul. In total, collection, transfer, and haul of garbage accounted for about 56 percent of the cost to manage this garbage. Another 29 percent, or almost $6.3 million, was spent to rail-haul and dispose of this garbage.

G&A expenses accounted for 14 percent of the $21.6 million. Because most of the G&A expenses were allocated in proportion to all other expenses, the percentage of these costs is constant for garbage, recyclables, and yard waste.

About 20 percent of the promotional and educational and miscellaneous recycling and planning expenses incurred by the Utility for Analyzed Waste was assigned to the management of garbage. This amount, $152,000, is about 0.7 percent of the $21.6 million allocated to the management of garbage.

4.5.2 Cost of Managing Recyclables

The 54,600 tons of recyclable materials included in the 232,000 tons of Analyzed MSW consisted of 48,290 tons collected as part of the curbside collection program, 2,970 tons collected as part of the apartment recycling program, and 3,340 tons of collected white goods.

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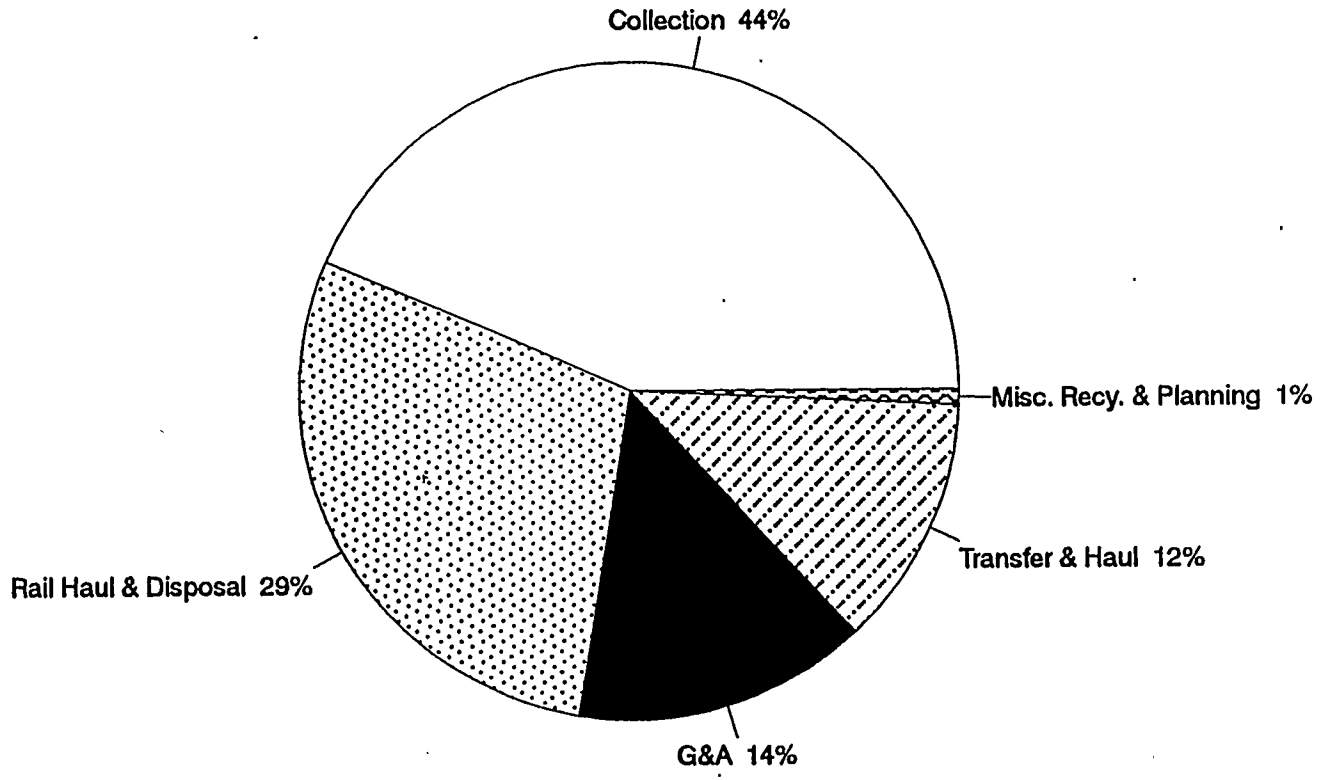
[41] The allocation procedures are provided in the tables presented in Appendix B.

FIGURE 4-4: ALLOCATION OF COSTS TO MANAGE GARBAGE

Allocation by Functional Area
(Cost to Manage 142,000 tons of Garbage)

TOTAL COST IS $21,630,000



It should be noted that these tonnages reflect the quantity of recyclable materials collected and not necessarily the amount recovered for re-use or sale. Of the 54,600 tons of recyclables collected in FY 1992, 51,075 tons are estimated to have been re-used, stockpiled, or sold (i.e., recycled).

Because the MRFs that receive and process the recyclable materials are privately operated and also accept materials collected from other customers, an exact accounting of any residue or unsold materials is not known. Officials from Recycle America indicated that some of the glass, i.e., mixed cullet, recovered at its MRF was being stockpiled for possible future use. Furthermore, a significant, but unknown, amount of glass was broken during collection and processing by Recycle Seattle because glass was mixed with other recyclables by the homeowners prior to collection. This broken glass was discarded as residue from the MRF.[42]

A quantity of glass collected by both firms is either disposed of as residue or is unmarketable and stockpiled for possible future use. Because of breakage during collection, the Utility reports that Recycle America is unable to market between three and five percent of the glass it collects.[43] Since approximately 20 percent of the material collected by Recycle America is glass,[44] an estimated 0.8 percent (i.e., four percent of 20 percent) of the 25,475 tons, or 204 tons of glass, was stockpiled for potential future use. Furthermore, 127 tons, or 0.5 percent[45] of the material collected, is reported to be contamination.[46] For this analysis, the mixed cullet that is stockpiled is viewed as material that is recovered for potential recycling. Therefore, only the 127 tons of contamination is subtracted from the total amount collected to estimate the tons of materials recycled. Thus, an estimated 25,348 of the 25,475 tons collected by Recycle America in FY 1992 was stockpiled or recycled.

Given the collection and processing system used by Recycle Seattle in FY 1992, the quantity of glass in the residue is relatively high. For this analysis it is assumed that about 50 percent of the glass collected by Recycle Seattle in FY 1992 was disposed of as residue.[47] Since approximately

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[42] Starting in FY 1993 Recycle Seattle required each homeowner to place the glass containers in a separate insert to the collection bins. At the curb the driver sorts the glass by color and places it in special compartments on the truck. This new method of collection should significantly increase the amount of salable glass collected by Recycle Seattle. It will also improve the quality of some of its paper products by reducing or eliminating the impingement of glass in the paper during processing.

[43] "Seattle's Road To Recovery - Seattle's Curbside Recycling Program," page 4.

[44] "Seattle's Curbside Recycling Program," page 3.

[45] "Seattle's Road To Recovery -- Seattle's Curbside Recycling Program," page 3.

[46] "Seattle's Road To Recovery -- Seattle's Curbside Recycling Program," page 3.

[47] Rabanco indicated that about 50 percent of the glass collected may have become residue because of excessive breakage in collection and processing. (Meeting with A. Cohen and C. Voell, 1993).

20 percent of the materials collected by Recycle Seattle is glass[48], an estimated 10 percent (50 percent times 20 percent) of the 22,812 tons, or 2,281 tons, of glass collected by Recycle Seattle was disposed of as residue. Furthermore, an additional 616 tons, or 2.7 percent of the material collected, is reported to be contamination.[49]

It is further assumed in this analysis that 85 percent of the white goods[50] (i.e., 2,839 of the 3,340 tons of recyclables) and all of the 2,973 tons of recyclables collected as part of the apartment recycling program were recycled.

Therefore, of the 54,600 tons of recyclables collected, 51,075 tons are assumed to have been used or sold, i.e., recycled, in FY 1992. This estimate only affects the average cost calculations and not the total cost calculation.

The Utility's FY 1992 cost of managing the 54,600 tons of recyclables collected and processed in the IMSWM System was approximately $4.5 million. The Average Cost of the 51,075 tons recycled in FY 1992 is $88 per ton.[51] The allocation by functional area of this $4.5 million is shown in Figure 4-5.

Of the $4.5 million, approximately $3.4 million (75 percent) was for collection and processing.[52] Miscellaneous recycling and planning expenses accounted for another $305,000 (7 percent) of this cost. These costs include such things as market development, waste stream projections and analyses, and planning documents.[53] Promotional and educational expenses attributed to the management of recyclables, such as the school outreach program and curbside recycling education and information programs, were $172,000 in FY 1992 (i.e., 4 percent of the total cost). This accounts for about 64 percent of the total $269,000 promotional and educational expenses allocated to Analyzed MSW.[54] G&A expenses account for the remaining 14 percent of the $4.5 million cost to manage the recyclables included in FY 1992 Analyzed MSW.

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[48] "Seattle's Curbside Recycling Program," page 3.

[49] "Seattle's Road To Recovery -- Seattle's Curbside Recycling Program," page 3.

[50]Based on information provided by white good processors, about 15 percent, by weight, of the white goods collected are disposed of as residue.

[51] Because the objective of any recycling program is to recover materials that are eventually reused, this report presents average cost per ton sold/re-used rather than an average cost per ton collected.

[52] Because the Utility's contracts with Recycle America and Recycle Seattle are for collection and processing, separate collection and processing costs could not be calculated.

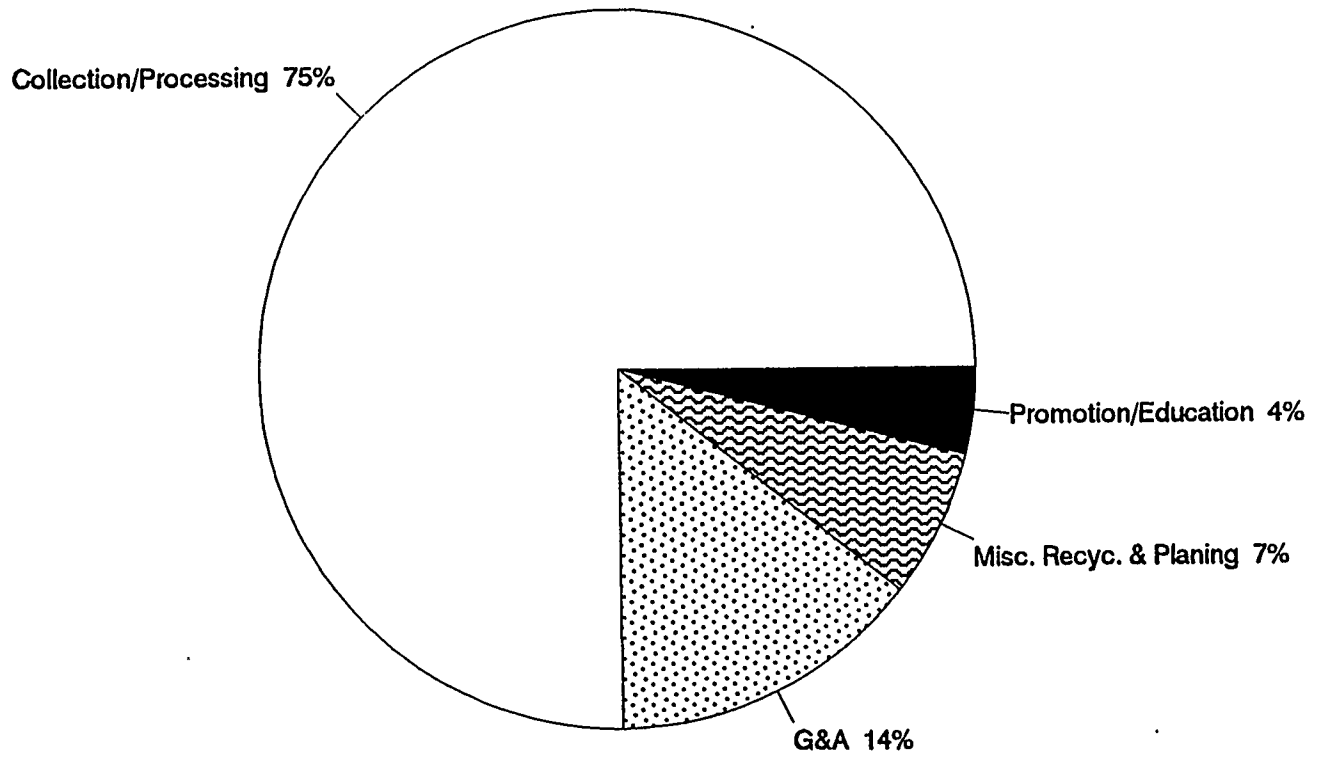
[53] A complete list is provided in Table B.9 of Appendix B.

[54] See Table B.8 of Appendix B for allocation of promotional and educational expenses.

FIGURE 4-5: ALLOCATION OF COSTS TO MANAGE RECYCLABLES

Allocation by Functional Area
(Cost to Manage 54,600 tons of Recyclables)

TOTAL COST IS $4,510,000



4.5.3 Costs of Managing Yard Waste

The cost to the Utility of managing the 34,790 tons of yard waste included in FY 1992 Analyzed Waste was about $4.1 million. The Utility reports that less than one percent of the yard waste collected was contamination, consisting primarily of plastic bags.[55] Assuming that 99 percent of the 34,790 tons of yard waste collected, or 34,442 tons, was converted into compost that was sold or used, the Average Cost of yard waste recycling was $119 per ton sold.

The allocation of this $4.1 million by functional area is shown in Figure 4-6. Seventy-one percent, or about $2.9 million, was for collection and processing. An additional $475,000, or 12 percent, was for transfer and haul.[56] In total, about 83 percent of the cost to manage the 34,790 tons of yard waste was spent on collection, transfer, haul, and processing.[57] G&A expenses, as was the case for recyclables and garbage, accounted for 14 percent of the cost. Miscellaneous recycling and planning, and promotional and educational expenses accounted for about four percent of the cost.

4.5.4 Costs of Managing HHW

The cost of managing the 798 tons of HHW processed in FY 1992 was about $1.4 million. This cost does not include the cost of collection because most HHW is delivered to drop-off sites by residences and businesses. About 68 percent of this cost was for operation of HHW drop-off sites, 8 percent was for miscellaneous recycling and planning expenses (see Table B.9 of Appendix B), and 6 percent was for promotion and education (see Table B.8 of Appendix B). G&A expenses account for 14 percent of this cost. The balance of about 4 percent is attributed to used oil operations (see Table B.14 of Appendix B).

4.6 Marginal Costs, Marginal Costs of Substitution, and Program Incremental Costs

The Utility's Average Costs (i.e., the total cost divided by the number of tons managed) to manage the garbage, recyclables, and yard waste constituting Analyzed MSW in FY 1992 were $152, $88, and $119, respectively. It would be erroneous to subtract the respective Average Costs of recyclables and yard waste management from the Average Cost of garbage management and thereby conclude that $64 per ton (i.e., $152 minus $88) was saved for every ton of material recovered and recycled and that $33 per ton (i.e., $152 minus $119) was saved for every ton of yard waste recovered and composted in Seattle.

Furthermore, it is misleading to conclude that curbside recycling or yard waste collection and composting are "cheaper" (thus, implying a savings) if their Average Costs are less than the

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[55] "Seattle's Road To Recovery - Seattle's Yard Waste Programs," page 5.

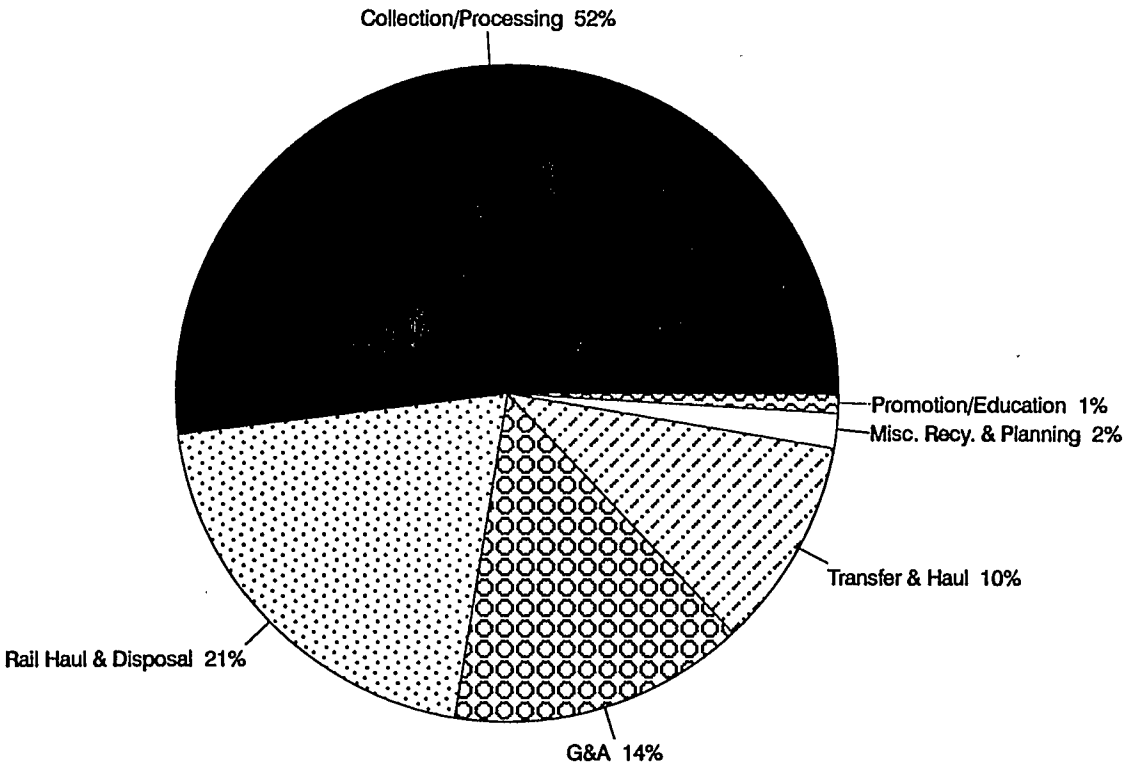
[56] Only transfer and haul costs incurred by the SWU are included. Transfer and haul costs incurred by U.S. Disposal are included in the collection/processing cost.

[57] The U.S. Disposal contract includes collection, transfer, haul, and processing of yard waste. Therefore, a separate accounting of each component is not possible.

FIGURE 4-6: LOCATION OF TOTAL COSTS FOR IMSWM SYSTEM IN FY92

Allocation by Functional Area
(Cost to Manage 232,000 tons of Analyzed MSW)

TOTAL COST IS $30,230,000



Average Cost of disposal.[58]

This section demonstrates why this sort of calculation is inappropriate and can lead to erroneous conclusions. This is done by explicitly calculating the savings or costs of diverting materials or yard waste from disposal to recycling and/or yard waste composting and vice versa (i.e., calculating the Marginal Cost or Savings of Substitution) and by comparing the cost of the disposal only system, and variations thereof, with the cost of disposal and recycling and/or yard waste composting (i.e., estimating Program Incremental Costs or Savings).

4.6.1 Marginal Costs

Marginal Cost (or Savings) is defined as: "The cost (or savings) of managing an additional ton of MSW, garbage, recyclables, or yard waste."[59] Marginal Cost is generally defined for the management of only one additional ton. However, for straight line (linear) functions (such as are applicable to the Seattle programs analyzed herein), it is defined as the per-ton cost of increasing, or decreasing, the tonnage managed by a small amount (such as plus or minus 2,600 tons per year, i.e., 10 tons per day).

Furthermore, Marginal Cost is defined for a given system, such as Seattle's IMSWM System as it existed in FY 1992. Any increase (or decrease) in tonnage managed is assumed to occur without changes to the Utility programs already in place. For example, the reason for an increase in the tonnage of recyclables managed would be that more people decide to participate in the existing program or that more recyclables are generated per participating household, rather than because of a program change, such as an increase by the Utility in the number or types of

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[58] Such a comparison of Average Costs was made in a report entitled, "The Economics of Recycling and Recycled Materials," prepared for The Clean Washington Center, a division of the Department of Trade & Economic Development by the Sound Resource Management Group, Inc. and released on June 30, 1992. In this report the authors compared their calculated $89.90 Average Cost of the curbside recycling program in Seattle in 1992 to their calculated $136.68 Average Cost of collecting and disposing of garbage in 1992 and concluded that, "recycling is cheaper than disposal for all materials collected through the curbside program" (page 31 and 33). Similarly, by subtracting the $111.24 Average Cost of Seattle's Yard Waste Program from the $136.68 Average Cost of disposal, the authors concluded, "When system costs are allocated according to weight collected, curbside yard waste collection and composting was cheaper in Seattle in 1992 than yard waste disposal by $25 per ton" (page 31).

The small difference between the Average Costs calculated in The Clean Washington Center report and in this study can be attributed to the methods used to allocate G&A expenses. Furthermore, only the North Sector (i.e., Recyclable America's) curbside recycling program was analyzed The Clean Washington Center Report. The authors of The Clean Center Report do caution the reader that their "report's data does not directly support conclusions regarding ... cost of a disposal only system ('before') versus a disposal plus recycling system ('after') or "savings or 'avoided costs' from diverting materials from disposal to recycling or vice versa" (page 11).

[59] See Appendix A "Glossary of Terms" for this and other definitions.

materials collected or an intensification of its educational or promotional efforts.

The Marginal Costs for managing (collecting and processing or disposing of) garbage, recyclables, and yard waste are provided in Table 4-4. Because multiple contracts exist for each service, the northern and southern sectors of the City have differing Marginal Costs. All of the Marginal Costs presented in Table 4-4 reflect contractual prices and were calculated using the methodology and assumptions presented in Appendix C. Table 4-5 shows the components of the Marginal Cost calculations.

The Marginal Cost of the management of garbage in the northern sector is $73.06 per ton. The Marginal Cost of the management of garbage in the southern sector is $77.67 per ton.

The Marginal Cost of the management of recyclables in the northern sector is $56.95. In the southern sector, the Marginal Cost of recyclables management is $67.52.

The Marginal Cost of the management of yard waste in the northern sector is $74.89, while in the southern sector it is $93.91.

4.6.2 Marginal Cost of Substitution

The Marginal Cost (or Savings) of Substitution is defined as "the net cost (or savings) of managing an additional ton of recyclables or yard waste less the savings (or cost) of managing one less ton of garbage." (Again, although this definition is generally applied to the management of only one additional ton, in this analysis it is applied to the management of a small amount of tonnage.) In other words, this would have been the cost (or savings) in FY 1992 of diverting materials, such as yard waste from disposal to recycling or to yard waste composting, and vice versa.

Calculating a Marginal Cost of Substitution reveals the cost (or savings) of substituting one waste-management method for another for a small tonnage of a particular waste stream category (in this case, recyclables or yard waste). It shows how much it would cost or save to recover, for example, an additional 10 tons per day of recyclables or yard waste through existing recycling or composting programs rather than to dispose of that tonnage as garbage. For example, the Marginal Cost of Substitution in FY 1992 for recyclables in the southern sector is negative, i.e., -$10.15, which is actually a savings of $10.15 per ton (i.e., the Marginal Cost for recyclables of $67.52 per ton minus the Marginal Cost for garbage of $77.67 per ton). This means that given its current IMSWM System programs, the Utility could have saved about $10 per ton in the southern sector by recovering any recyclables that were being discarded by residents as garbage in FY 1992. Similarly, a savings of almost $16 per ton could have been realized in the northern sector through more efficient separation of recyclables or greater participation rates.[60] These savings are significantly lower than the $64 per ton which results from subtracting the Average

[60] Because the sector definitions are different for garbage and recyclables, strictly speaking these results apply only to those households that are served by General Disposal and Recycle America or U.S. Disposal and Recycle Seattle. The Marginal Cost of Substitution for other combinations of contractors can easily be calculated by subtracting the appropriate Marginal Costs.

TABLE 4-4: MARGINAL COST (SAVINGS) AND MARGINAL COST (SAVINGS) OF SUBSTITUTION

MANAGED MSW	MARGINAL COST ($/ton)	MARGINAL COST OF SUBSTITUTION ($/ton)
GARBAGE		
North Sector	73	NOT APPLICABLE
South Sector	78	NOT APPLICABLE
RECYCLABLES		
North Sector	58	(16)
South Sector	68	(10)
YARD WASTE		
North Sector	75	2
South Sector	93	15

NOTES:

1. Analysis does not consider different taxes charged for garbage, recyclables, and yard waste. Inclusion of tax differencials would, therefore, screw results, because they reflect governmental policy and not costs of providing services.
2. Analysis based upon contractual arrangements between service companies and the SWU.
3. North and South Sectors for recyclable collection are different that those defined for garbage and yard waste collection.

TABLE 4-5: COMPONENTS OF MARGINAL COST CALCUALTIONS

MANAGED MSW	NORTH SECTOR ($/ton)	SOUTH SECTOR ($/ton)
GARBAGE		
Collection	29.34	33.95
Transfer	-	-
Disposal	43.22	43.22
Total	73.06	77.67
RECYCLABLES		
Collection & Processing	56.95	67.52
YARD WASTE		
Collection	62.39	93.31
Transfer	-	inc.
Processing	12.50	inc.
Total	74.89	93.31

Cost of managing recyclables from the Average Cost of managing garbage. Clearly that method of calculation overestimated the savings of recycling additional small tonnages of material.

On the other hand, the Marginal Cost of Substitution for yard waste in the northern and southern sectors is $2 and $16 per ton, respectively. That is, small increases in the management of yard waste with a corresponding decrease in the management of garbage would have cost $2 per ton in the northern sector and $16 per ton in the southern sector.

The erroneousness of subtracting Average Costs is even more profound for yard waste. Subtracting the Average Cost for managing yard waste from the Average Cost of managing garbage leads not only to an overestimation of the realized savings, but also results in the false conclusion that there would actually be savings.

Part of the reason for the false conclusions caused by subtracting Average Costs from one another is that such a calculation does not account for the independent and differing impacts that changes in tonnage have on fixed and variable costs. Subtracting Average Costs assumes that the impacts of fixed and variable costs are proportional. The Marginal Costs of Substitution shown in this section clearly illustrate that such an assumption is incorrect. For a more detailed discussion of this point see Appendix C.

By 1995 the rates for the rail-haul and landfill services charged by Washington Waste Systems will decrease by 6 to 12 percent, because the East Washington Landfill rates, provided in Table 4-6, will apply. These rates will go into effect whether or not the East Washington Landfill is opened as scheduled. Furthermore, the curbside collection contracts with Recycle America and Recycle Seattle were extended beyond FY 1992, with significantly higher rates that took effect in September 1993. As a result, the Marginal Savings of substitution of the curbside recycling program is anticipated to decrease, while the Marginal Cost of substitution of the yard waste and composting program is anticipated to increase over the next few years.

It is important to remember that the results presented for both Marginal Costs and Marginal Costs of Substitution are applicable only to relatively small changes in tonnage. In the following section, the cost impacts of larger tonnage changes are discussed.

4.6.3 Program Incremental Costs

Program Incremental Cost (or Savings) is defined as "the difference between the cost of managing MSW with and without the inclusion of a particular program." In this subsection the estimated Program Incremental Costs of the curbside recyclables and curbside yard waste collection, processing, and marketing programs are presented, respectively, as are the Program Incremental Costs of both programs combined.

The Program Incremental Costs presented below reflect FY 1992 price levels and contractual relationships. These estimates should not be interpreted as the costs or savings of eliminating the current programs. Because of existing contractual commitments and sunk capital expenditures, the costs of eliminating existing programs could be substantially different from the costs presented here. Rather, the Program Incremental Costs presented here should be interpreted as the costs or savings of the inclusion of these programs.

TABLE 4-6: RAIL HAUL AND LANDFILL RATES

BASE AMOUNT PER TON	1989 Base Prices		1992 Base Prices	
	Columbia Ridge	East Washington	Columbia Ridge	East Washington
Less than 450,000 tons per year	36.67	34.40	43.22	40.54
450,000 tons per year or more	35.90	31.38	42.31	36.99
525,000 tons per year or more	35.65	31.19	42.02	36.76
600,000 tons per year or more	35.40	30.99	41.72	36.53
800,000 tons per year or more	35.15	30.79	41.43	36.29
1,000,000 tons per year or more	34.90	30.59	41.13	36.05

NOTE: 1992 Rates based on monthly invoices and include average incidental charges and payments.

SOURCE: "Contract Between the City of Seattle and Washington Waste Systems, Inc.for the Transportation and Disposal of Waste."

Four Cases have been analyzed. Case 1 is the base case, representing the Utility's current garbage, recyclables, and yard waste programs. Case 2 assumes there is no curbside recycling program. Case 3 assumes there is no yard waste program. Case 4 assumes there is neither a curbside recycling nor a yard waste program.

In all four Cases, a total of 530,947 tons of MSW are managed. Table 4-7 presents the make-up of this total per each Case. In Case 1, 433,768 tons of garbage, 45,919 tons of yard waste, and 51,260 tons of recyclables constitute the total 530,947 tons of MSW considered in the analysis. All of the garbage that is rail-hauled (i.e., 433,768 tons in FY 1992) is included in the analysis so as to estimate the effect of the quantity discounts shown in Table 4-6.

In Case 2, it is assumed that there is no curbside recycling program, that the 25,475 tons of recyclables collected by Recycle America and 1,486 tons collected as part of the apartment recycling program are collected as garbage by General Disposal, and that the 22,812 tons of recyclables collected by Recycle Seattle and 1,487 tons collected as part of the apartment recycling program are collected as garbage by U.S. Disposal. Because there was an extensive recyclables drop-off program in Seattle prior to the implementation of the curbside program, it is assumed that the 5,558 tons of recyclables currently being self-hauled to drop-off sites, including the transfer stations, would still be diverted from the disposable (i.e., garbage) waste stream.

In Case 3, it is assumed that without the yard waste program, the 11,129 tons of self-hauled yard waste delivered to the transfer stations is mixed with the garbage and eventually landfilled. Thus, all of the 45,919 tons of yard waste sent to the Cedar Grove Composting Facility in FY 1992 are assumed to be disposed of at the Columbia Ridge Landfill.

In Case 4, the assumptions for Cases 2 and 3 are combined. This results in all 530,947 tons being disposed of as garbage at the Columbia Ridge Landfill. Of this amount, 148,187 tons are collected by General Disposal, 80,017 tons are is collected by U.S. Disposal, 108,405 tons are self-hauled to the transfer stations, and 194,338 tons are self-hauled to the railhead.

The estimated Program Incremental Costs are presented in Table 4-8. The portion of these costs which represents internal (i.e., non-contracted) Utility activities is provided in Table 4-9. The methodology, assumptions, and data used to make these estimates are provided in Appendix C.

The Program Incremental **Savings** of the curbside recycling program is estimated to be about $17,200. Of the 51,260 tons of recyclables collected in FY 1992, an estimated 48,236 tons were sold, used, or stockpiled. The per-ton **savings** of the recycling curbside program is estimated to be about $0.36 per ton of sold or used (i.e., recycled) recovered materials. The Program Incremental **Cost** of the curbside yard waste program is estimated to be about $568,500. Of the 34,790 tons of yard waste collected in FY 1992, 34,442 were processed into compost. The per-ton **cost** of the curbside yard waste program is estimated to be about $17 per ton composted. The Program Incremental **Cost** of both the curbside recycling and yard waste programs is about $516,800, or $6 per ton of material recycled or composted.[61]

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[61]The Program Incremental Costs are not additive; therefore, the incremental cost of both programs is not equal to the weighted sum of each individual program.

TABLE 4-7: TONS OF MSW FOR ALTERNATIVE CASES

SOUCE OF MSW	CASE 1 CURRENT PROGRAM	CASE 2 NO CURBSIDE RECYCLING	CASE 3 NO YARD WASTE PROGRAM	CASE 4 NO RECYCLING & YARD WASTE
GARBAGE				
General Disposal	96,679	123,640	121,226	148,187
U.S. Disposal	45,475	69,774	55,718	80,017
Self Haul to Transfer Stations	97,276	97,276	108,405	108,405
Self Haul to Railhead	194,338	194,338	194,338	194,338
RECYCLABLES COLLECTION, PROCESSING, & MARKETING				
Recycle America	25,475	0	25,475	0
Recycle Seattle	22,812	0	22,812	0
Apartment Recycling	2,973	0	2,973	0
YARD WASTE COLLECTION, PROCESSING, & MARKETING				
General Disposal	24,547	24,547	0	0
U.S. Disposal	10,243	10,243	0	0
Self Haul to Transfer Stations	11,129	11,129	0	0
Processing (North & Self Only)	35,676	35,676	0	0
TOTALS	530,947	530,947	530,947	530,947

TABLE 4-8: PROGRAM INCREMENTAL COSTS (SAVINGS)

PROGRAM	TONS	TOTAL INCREMENTAL COST (dollars)	UNIT INCREMENTAL COST ($/ton)
Curbside Recycling	48,236	(17,200)	<(0.5)
Curbside Yard Waste	34,442	568,500	17
Both Programs	82,678	516,800	6

NOTE: Program incremental costs are not addative, therefore, incremental cost of both programs is not the weighted sum of each individual program.

TABLE 4-9: SWU'S NON-CONTRACTUAL PROGRAM INCREMENTAL SAVINGS (COSTS)

FUNCTION	RECYCLABLES	YARD WASTE	BOTH PROGRAMS
General & Administrative	$148,500	$33,750	$249,750
Taxes	0	0	0
Collection/Processing	31,078	88,780	119,858
Transfer & Haul	(338,725)	22,165	(316,560)
Promotion & Education	172,162	65,438	237,600
Misc. Recycling Expenses	183,293	64,023	386,119
Capital Costs	(13,900)	0	(13,900)
Total	$182,400	$274,200	$662,900

To estimate Program Incremental Costs (or Savings), a number of assumptions had to be made concerning market prices for collection and disposal services, and the level of changes in G&A expenses and/or changes in ancillary programs. The impact of these assumptions on the estimated Program Incremental Cost (or Savings) are discussed below.

The Program Incremental Cost analysis assumes that the current Structure Prices (i.e., fixed prices) and Tonnage Prices (i.e., variable prices) for collection of garbage without a curbside recycling and/or yard waste composting program would be the same as the actual FY 1992 garbage collection prices. To test the reasonableness of this assumption, CSI conducted an engineering assessment of garbage collection costs and determined that the per-ton Tonnage Price that would have been paid to the contractor would have more than covered the contractor's incremental cost, including a profit margin. Therefore, it is reasonable to assume that the garbage collection market prices, and in particular the Structure Price and per-ton Tonnage Price, without these programs would be no greater than these market prices charged in FY 1992 with the curbside recycling and yard waste composting programs in place.

In the engineering assessment referred to in the proceeding paragraph, collection costs were estimated as function of: types of services provided (e.g., garbage, recyclables, yard waste, and/or bulk waste collection; tonnage collected for each service provided; waste composition; collection frequency; vehicle sizes and types; compaction ratios; dwell times; shift hours; population density; distance to transfer stations or disposal sites; labor rates; vehicle capital, operation, and maintenance costs; and participation rates. Initially these parameters were set to replicate known conditions (e.g., current collection practices and costs) which is referred to as the base case. The costs of varying collection practices (e.g., eliminating the curbside recycling program) were then estimated and compared to the base case results.

The Program Incremental Cost (or Savings) presented above assume the contractual prices for the railhaul and disposal system, including the quantity discounts (see Table 4-5), reflect the market price for these services with or without a curbside recycling and/or yard waste program(s). This is a reasonable assumption because the railhaul and disposal contract is long-term, i.e., up to 30 years, and prices are provided for these services for quantities of garbage in excess of one million tons a year. As shown below, the impact of the quantity discount on the estimated Program Incremental Savings of the curbside recycling program would increase by about $395,000, yielding a total estimated Program Incremental Savings of about $412,000, or $8 per ton. Similarly, without the quantity discount, the estimated Program Incremental Cost of the yard waste program would be reduced by about $395,000, resulting in an estimated Program Incremental Cost of about $174,000, or about $5 per ton. Eliminating the quantity discount would decrease the Program Incremental Cost of both programs by about $521,000. This implies that the magnitude of the quantity discount alone accounts for the entire Program Incremental Cost of both programs.

Although these results are specific to Seattle and the Utility's contractual relationships, they clearly demonstrate that economies of scale can have significant effects on Program Incremental Costs. In part, errors occur when Average Costs are subtracted from one another to estimate program costs because of economies of scale in various programs of an IMSWM system.

The assumed incremental G&A expenses can have a significant impact on the estimated Program Incremental Costs. For this analysis, it was assumed that $148,500, or the equivalent of about

four additional full-time employees, was required for customer service, procurement, planning, and other G&A activities related to the curbside recycling program. This is about 23 percent of the $648,000 G&A expense allocated to recycling. Because the estimated Program Incremental Savings of the curbside recycling program is close to zero, any change to this assumed incremental G&A expense can significantly change the results of the analysis. In particular, if the incremental G&A expenses are only a little greater, e.g., less than one full-time equivalent employee, then there would be a **cost** and not a **savings** for the curbside recycling program.

Because there are no separate contracts for yard waste collection, only one commodity is collected, and fewer planning or marketing studies need to be managed, the incremental G&A cost for the yard waste program is assumed to be less than for the curbside recycling program. For this analysis, it was assumed that $33,750, or the equivalent of one additional full-time employee, was required for customer service, procurement, planning, and other G&A activities related to the yard waste program. This is about six percent of the $589,000 G&A expense allocated to the yard waste program.

The incremental G&A expense for both programs was assumed to be $249,750, or the equivalent of about six additional full-time G&A employees. The incremental G&A expense for both programs is assumed to be greater than the sum of each program's incremental G&A expenses because additional planning and administrative staff members, e.g., a director of recycling, are assumed to be required for a more complex organization and program. Because the curbside recycling and yard waste programs are the main focus of the waste diversion efforts, it is also likely that without these two programs many of the other recycling activities (e.g., commercial recycling and backyard composting) would be limited or eliminated. The estimate of Program Incremental Costs in this study, however, is limited to the analysis of only those costs related to the curbside recycling and yard waste programs, i.e., any incremental costs or savings or ancillary programs are not included in the analysis.

Another important set of assumptions for estimating the Program Incremental Costs are related to the determination of the incremental Miscellaneous Recycling and Planning costs. For the curbside recycling program, about $183,300 of the Miscellaneous Recycling and Planning costs was assumed to be incremental costs. This amount is the sum of the total "Recruiting," "Apartment Recycling," and "Market Development" costs shown in Table B.9 of Appendix B. These expenses were used as a proxy, since a portion of all of the Miscellaneous Recycling and Planning expenses may not have been incurred if there were no commitment to a curbside recycling program.

For the yard waste program, about $64,000 of the Miscellaneous Recycling and Planning costs were assumed to be incremental costs. This amount is the sum of the total "Yard Waste Process," "Overall Yard Waste," "Compost Quality," and "Co-Composting" costs shown in Table B.9 of Appendix B. Again, these expenses were used as a proxy, since a portion of all the Miscellaneous Recycling and Planning expenses may not have been incurred if there were no commitment to the yard waste program.

For both the curbside recycling and yard waste programs, about $386,000 Miscellaneous Recycling and Planning costs were assumed to be incremental costs. This amount is the sum of incremental Miscellaneous Recycling and Planning costs attributed to each program plus the cost of the "Waste Stream Projection" and "Waste Stream Composition" studies. If there were no

curbside recycling and yard waste programs, then it was assumed that the waste studies would most likely not have been performed.

The above discussion indicates that the estimation of Program Incremental Costs requires that some assumptions be made concerning the level of expenditure that would have been made if certain programs had not been implemented. As a general rule, the incremental costs should be less than the average cost allocated to an activity.

5. Energy Usage Analysis

The primary forms of energy used within Seattle's IMSWM System are transportation fuels (gasoline and diesel fuel) for collection, haul, and facility vehicles, and electricity consumed internally by solid waste processing or disposal facilities. The only energy produced within the System is methane gas generated at the Columbia Ridge Landfill. However, the gas is flared and, therefore, is not used as a productive energy resource.

5.1 Data Input

In order to determine the total energy usage for collection of residential garbage, yard waste, and recyclables within the IMSWM System, collection vehicle fleet data, including fuel consumption and tonnage collected, was requested from U.S. Disposal, General Disposal, Recycle Seattle, and Recycle America. Information was also requested from the Utility on the fuel consumption and tonnages hauled by vehicles transporting garbage from the City transfer stations to the Union Pacific railyard. In addition, information was requested from Washington Waste Systems regarding fuel usage for rail-hauling to the Columbia Ridge Landfill. The only information that was obtained from these requests was collection vehicle information from Recycle America, which collects recyclables in the northern sector of the City. The results of the analysis of this data are presented below.

As regards energy consumed in the processing or disposal of waste, internal facility electricity consumption and fuel usage associated with any vehicle used on the premises was requested from the two City transfer stations, the Rabanco Recycling Facility, the Recycle America Materials Recovery Facility, the Cedar Grove Composting Facility, the Union Pacific Railyard, and the Columbia Ridge Landfill. The only information received from these requests was internal electricity consumption and vehicle fuel usage at the Recycle America Materials Recovery Facility. These results are also discussed below.

It was intended that data collected would enable the estimation of the total energy use and per-ton energy use associated with collecting, processing, and disposing of an average ton of garbage, yard waste, and recyclables, respectively. However, given the limited amount of information received, the only estimation that could be made was the total energy use and per-ton energy use associated with the collection and processing of source-separated recyclables processed at the Recycle America MRF. Recycle America provided information on each vehicle in its collection fleet and each vehicle used on-site at the MRF. This data included make, model, model year, hours used, gallons consumed, and operating and maintenance costs. Recycle America also provided copies of its billing statements for facility electricity usage from Seattle City Light. This information, along with tonnage information provided by Recycle America, allowed an estimation of the energy used for collecting and processing recyclables from the northern sector of the City.

5.2 Analysis Results

With respect to collection, Recycle America's vehicles consumed 92,548 gallons of fuel in collecting 25,475 tons of recyclables from the City's North Sector. Assuming a conversion rate of 146,390 Btus per gallon of diesel fuel, these collection vehicles consumed 13 billion Btus of energy. On a per-ton basis, each ton of recyclables collected by Recycle America required 3.60 gallons, or 532,000 Btus, of energy.

Processing energy usage consists of both the energy used to power the facility itself (e.g., process equipment, lights, heat, etc.) and the fuel used by vehicles on the facility premises. The Recycle America MRF processed just over 83,000 tons of recyclable materials in FY 1992. However, only 30.5 percent of those recyclables were collected from Seattle residents. Therefore, only 30.5 percent of the total internal electricity and vehicle fuel usage was attributed to the processing of Seattle recyclables. It was estimated that the total energy consumption associated with processing Seattle recyclables at the Recycle America MRF was 1.1 billion Btus. On a per-ton basis, processing one ton of recyclables required 43,451 Btus of energy, or about 0.30 equivalent gallons of diesel fuel. Together, collecting and processing one ton of source-separated recyclables from the North Sector of Seattle required approximately 575,300 Btus of energy (or about 3.9 equivalent gallons of diesel fuel per ton) in FY 1992.

CSI was able to determine approximately 15,700 tons, or about one-third, of the materials recovered from the curbside recycling program were shipped for remanufacturing. Estimated energy consumption for such shipping is included in the analysis, but the energy consumed in the remanufacturing process is excluded because it is beyond the scope of this report. Since many remanufacturing processes which utilize recovered material use less energy than virgin material processes, this exclusion may understate the overall energy efficiency of recycling. The one-way shipping distances ranged from three to 485 miles. The weighted average distance was about 110 miles. Assuming the average energy consumption for a transfer vehicle over these distances is 0.023 gallons per ton-mile,[62] then the estimated energy consumed to ship these recovered materials to the remanufacturers ranged from less than 0.10 gallons per ton to just over 11 gallons per ton. The weighted average energy consumption to transport the recyclables to the remanufacturers was 2.5 gallons per ton (i.e., 110 times 0.023), or about 366,000 Btus per ton.

The average energy consumed per ton to collect, process, and haul recyclables collected from the curbside recycling program is about 741,000 Btus, or about 5.1 equivalent gallons of diesel fuel.

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[62] The energy consumed per ton-mile is based upon detailed transfer-trailer fuel consumption data obtained in Palm Beach County, Florida.

6. Environmental Regulations and Permit Requirements

The costs of compliance with the environmental regulations and permit requirements discussed in this section are reflected in the costs and energy consumption levels reported in this Case Study.

6.1 Overview of Federal Legislation and Regulations

The potential environmental impacts of solid waste management facilities have led to the development of an extensive network of federal and state regulations. Embodied in many federal environmental laws is an implicit federal-state partnership whereby the federal government sets the agenda and standards for pollution abatement while the states carry out the day-to-day activities of implementation and enforcement.

The Clean Air Act, most recently amended in 1990, established programs for protecting public health and the environment from exposure to gaseous emissions, including toxic air pollutants.[63] The Clean Water Act, most recently amended in 1987, is the principal federal law protecting the nation's waterways from pollution.[64] The Safe Drinking Water Act, most recently amended in 1988, established programs for protecting public drinking water systems from harmful contaminants.[65] The Solid Waste Disposal Act and Resource Conservation and Recovery Act (RCRA) of 1976, most recently amended in 1992 and currently undergoing Congressional review for reauthorization, is the main piece of federal legislation addressing landfill disposal regulation.[66] In that Seattle's IMSWM system does not include MSW combustion, the Clean Air Act did not apply to the facilities comprising the System.

Pursuant to the Clean Water Act, a solid waste management facility cannot cause a discharge of pollutants that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) into United States waters. The states are responsible for establishing water quality standards and are authorized to issue discharge permits. The NPDES permit requires the source to attain technology-based effluent limits, "best practicable control technology" (BPT), and "best available technology" (BAT). The initial BPT limitations focus on regulating discharges of convential pollutants such as bacteria and oxygen-consuming materials. The BAT limitations emphasize controlling toxic pollutants such as heavy metals, pesticides, and other organic chemicals. Table 6-1 provides a listing of the pollutants regulated under the NPDES.

A separate permit is required to dispose of dredge or fill material into the waters, including wetlands. The U.S. Army Corps of Engineers administers this permit program. Other regulations promulgated under the Clean Water Act include guidelines for using and disposing of sewage sludge.

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[63] The Clean Air Act and Major Amendments are codified as 42 U.S.C. 7401-7671, 1990.

[64] The Clean Water Act and Major Amendments are codified as 33 U.S.C. 1251-1387, 1987.

[65] The Safe Drinking Water Act and Amendments are codified as 42 U.S.C. 300f-300j-11, 1988.

[66] The Solid Waste Disposal/Resource Conservation and Recovery Act and Major Amendments are codified as 42 U.S.C. 6901-6991k, 1992.

TABLE 6-1

POLLUTANTS REGULATED BY THE NPDES PERMIT PROGRAM

OXYGEN DEMAND: Biochemical Oxygen Demand Chemical Oxygen Demand Total Oxygen Demands Total Organic Carbon Other	METALS: Aluminum Cobalt Iron Vanadium
SOLIDS: Total Suspended Solids (Residues) Total Dissolved Solids (Residues) Other	METALS (ALL FORMS) Other metals not specifically listed under Group 1
NUTRIENTS: Inorganic Phosphorus Compounds Inorganic Nitrogen Compounds Other	INORGANIC Cyanide Total Residual Chlorine
DETERGENTS AND OILS: MBAS NTA Oil and Grease Other Detergents or Algicides	MINERALS: Calcium Chloride Fluoride Magnesium Sodium Potassium Sulfur Sulfate Total Alkalinity Total Hardness Other Minerals

Source: 40 CFR, EPA, Part 123--"Appendix A - Criteria for Reporting in the NPDES Programs."

Pursuant to the Safe Drinking Water Act, a facility or practice cannot contaminate an underground drinking water source beyond the solid waste management facility boundary or beyond an alternate boundary. Table 6-2 provides the maximum contaminant levels as promulgated under this Act. The primary enforcement responsibility lies with the states, provided they adopt regulations as stringent as the federal requirements, develop adequate procedures for enforcement, maintain records, and create plans providing emergency water supplies.

Pursuant to RCRA, criteria were established to determine which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on public health or the environment.[67] The objective of these criteria is to mitigate adverse effects through the protection of floodplains, endangered species, surface water, and groundwater. These criteria also provide guidelines for sludge utilization and disposal under the Clean Water Act.

Subtitle D of RCRA primarily addresses non-hazardous waste, whereas Subtitle C of RCRA addresses hazardous waste disposal. In October 1991, the EPA promulgated revised Subtitle D regulations applicable to municipal solid waste landfills, with an effective date of October 1993. In general, the new regulations require liners, leachate collection, groundwater monitoring, and corrective action at municipal landfills.[68]

6.2 Overview of State Legislation, Regulations, and Permit Requirements

In the State of Washington, the authority for regulating solid waste management and protecting against negative environmental consequences of such management activities is granted within the Washington Solid Waste Management Law, Revised Code of Washington, Title 70, Chapter 95 (RCW 70.95), passed initially in 1969 (the "Solid Waste Management Law"). The State environmental agency, the Washington Department of Ecology (WDOE), is responsible for developing regulations pursuant to State legislation.

The regulations promulgated pursuant to The Solid Waste Management Law are codified in the Washington Solid Waste Regulations, Washington Administrative Code, Title 173, Chapter 304 (WAC 173-304). These regulations specify planning requirements, facility standards, and permitting requirements for all types of solid waste management facilities within the State.

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[67] 40 CFR, EPA, Part 257--Criteria For Classification of Solid Waste Disposal Facilities and Practices.

[68] On October 1, 1993, the Federal criteria for MSW landfills under subtitle D of RCRA were amended to extend the date of compliance for small landfills to April 9, 1994, and by delaying the effective date of subpart G, Financial Assurance, to April 9, 1995, for all MSW landfills. In addition, the MSW landfill criteria were amended by removing the exemption from the groundwater monitoring requirements and by delaying the date for compliance with all requirements of the MSW landfill criteria for two years for owners and operators of MSW landfill units in arid and remote areas that meet the qualifications of the small landfill exception in the MSW landfill criteria. (Federal Register, "Solid Waste Disposal Facility Criteria; Delay of Compliance and Effective Dates," Vol. 58, No. 189, pages 51536-51548, 1993.)

TABLE 6-2

MAXIMUM CONTAMINANT LEVELS PROMULGATED UNDER THE SAFE DRINKING WATER ACT

CHEMICAL	MCL (mg/l)
Arsenic	0.05
Barium	1.0
Benzene	0.005
Cadmium	0.01
Carbon Tetrachloride	0.005
Chromium (Hexavalent)	0.05
2,4-Dichlorophenoxy Acetic Acid	0.1
1,4-Dichlorobenzene	0.075
1,2-Dichloroethabe	0.005
1,1-Cichloroethylene	0.007
Endrin	0.0002
Fluoride	4.0
Lindane	0.004
Lead	0.05
Mercury	0.002
Methoxyclor	0.1
Nitrate	10.0
Selenium	0.01
Silver	0.05
Toxaphene	0.005
1,1,1-Trichloroethane	0.2
Trichloroethylene	0.005
2,4,5-Trichlorophenoxy Acetic Acid	0.01
Vinyl Chloride	0.002

Source: 40 CFR, EPA, Part 257 - "Criteria for Classification of Solid Waste Disposal Facilities and Practices."

The Solid Waste Management Law established the following priorities for solid waste collection, handling, and management, in the order listed: (1) waste reduction; (2) recycling, with source separation of recyclable materials as the preferred method; and (3) energy recovery, incineration, or landfilling of mixed wastes. In addition, a State goal of 50-percent recycling by 1995 was set. The stated purpose of the Law is, "to establish a comprehensive State-wide program for solid waste handling, and solid waste recovery and/or recycling which will prevent land, air, and water pollution and conserve the natural, economic, and energy resources of the state" [RCW 70.95.020].

The primary focus of the Solid Waste Management Law is on the development, maintenance, and content of county and city comprehensive solid waste management plans. The Law also grants authority to the WDOE to develop regulations for solid waste handling and facility siting, and to local boards of health to develop regulations for implementing management plans. The Law requires the environmental permitting of all facilities by local health departments and grants authority to the WDOE to develop minimum permitting requirements for the protection of public health and the environment.

6.3 Overview of Local Regulations

In the City of Seattle, solid waste management activities are regulated by the Seattle-King County Department of Public Health (DPH). Regulations pertaining to solid waste management and the potential environmental impacts of those management activities are codified as the King County Solid Waste Regulations, Title 10, Rules and Regulations No. 8 of the Code of the King County Board of Health.

Within the King County regulations are provisions for: the administration of solid waste management programs; the permitting of solid waste management facilities; fee structures for permitting and disposal; requirements for waste management practices, including general facility requirements; and requirements for specific processing or disposal facilities. For the most part, these regulations are modeled after the State requirements or respond directly to mandates issued within the State regulations to provide for sound solid waste management and protection of public health and the environment.

6.4 Facility Permitting Requirements

This section summarizes the environmental and worker-safety requirements mandated for each of the facilities included in the Seattle integrated municipal solid waste management (IMSWM) system. The State solid waste management regulations stipulate that all disposal sites and facilities must obtain a permit from the jurisdictional health department prior to operating. The State and local regulations are implemented through the requirements of the specific facility permits. The specific permits necessary for, and the requirements thereof that must be complied with by, each facility are discussed below.

Any substantial environmental, health, or safety issues that impeded a facility's ability to obtain or comply with the applicable permits and/or caused significant public complains are also discussed, to illustrate the relative complexity of the respective facilities' permit/operating requirements.

6.4.1 Seattle's North and South Transfer Stations

Seattle's North and South Transfer Stations were constructed in 1966 and 1968, respectively. At that time, environmental permitting requirements were minimal. However, over the last several years, as those requirements have increased in scope and stringency, the transfer stations have had to comply with new requirements in order to obtain annual operating permit renewals.

In accordance with current State and local regulation, these transfer stations must minimize visibility and access to the public and prevent public nuisances. The stations must be surrounded by fencing, trees, or other natural structures so as to be screened from view and blowing litter, and to control accessibility by the public as well as by rodents and other vectors. In addition, pollution control measures for the protection of surface and ground waters and air quality must be implemented, including odor and dust control. Scavenging must be prohibited. At least one attendant must be present during operational hours. Also, the facility must have adequate communication capabilities to immediately summon fire, police, or emergency service personnel.

Annual reports must be submitted to the WDOE detailing the quantity, density, and types of waste received at these transfer stations as well as any monitoring results from the facilities.

In 1986, amendments to the State and local solid waste management regulations required that plans of operation for all solid waste management facilities be developed and submitted. The DPH required that such plans for Seattle's two transfer stations include a description of the waste handled, inspection and monitoring programs, fire and explosion prevention and care, leak detection and corrective action plans, equipment maintenance plans, and a safety plan. A plan for regular inspections was also to have been included, including the maintenance of an inspection log to be made available to the local health department upon request. The final plans were submitted to the DPH in the spring of 1989.

In 1990, the Utility had begun implementing its plans to switch to rail-haul. Consequently, in February 1990, the Utility submitted new plans for the operation of the North and South Transfer Stations. In 1992, subsequent to these changes in operation, the two transfer stations were granted minor discharge authorizations from METRO's Industrial Waste Section for the discharge of washdown water, leachate, and vehicle-washing discharge. The authorization allows for a maximum of 5000 gallons per day of discharge and contains limits for pH, temperature, fats, oils and greases, flammables, settleable solids, organic compounds, hydrogen sulfide, and ten metals.

The only safety requirement with which the transfer stations must comply is the development of a safety program. The Utility developed such a program for its Engineering Department, and it was adopted by these two facilities. Components of the safety program include safety orientation, the presence of first aid and medical facilities, first aid and CPR training, supervisor training, traffic control training, an injury reporting and investigation system, regular safety meetings, the availability of personal protective equipment, a health and wellness program, a hearing conservation program, a worker right-to-know and hazardous chemicals program, field inspections, medical surveillance, and regular job safety analyses.

In FY 1992, the transfer stations were operated in conformance with these environmental requirements.

6.4.1.1 South Transfer Station Household Hazardous Waste Collection Facility

The City's Household Hazardous Waste (HHW) Collection Facility is housed adjacent to South Transfer Station. Under state regulations, HHW is categorized as a moderate risk waste (MRW), which is a category of solid waste that exhibits properties of hazardous waste but is not regulated under the State's rules for dangerous waste. Therefore, MRW (which includes HHW and small-quantity-generator, or SQG, waste) falls under the purview of the solid waste handling authority. Facilities handling HHW must at a minimum meet the requirements of the Minimum Functional Standards for Solid Waste Handling Facilities.

The City's HHW collection facility is also characterized in statutory language as a waste recycling facility. Given the facility's designation, application for a permit from the jurisdictional health department was required, as was the filing of an environmental checklist, as required by the State Environmental Policy Act (SEPA). Permit applications must include a description of the facility, the types of waste to be handled, a plan of operation, an inspection schedule and log, and documentation that any on-site wastewater treatment facility is operated in accordance with WDOE requirements. Annual reports to the DPH detailing the quantities and types of waste recycled during that year must also be submitted.

The DPH received the permit application for the HHW Collection Facility on September 17, 1991. In addition to the solid waste recycling facility permit, approvals from the Shoreline Management Division, and Fire and METRO discharge permits, were also required to be obtained for the facility. The facility permit was issued in March of 1992.

Construction and operation of the facility were designed to comply with State and local regulations. All wastes coming to the facility are sorted and packed by specially trained staff. Wastes are packed into 55-gallon drums conforming to the requirements of the hazardous waste regulations. Drums are stored inside metal hazardous waste sheds. One shed houses flammables, and the other houses poisons and corrosives with oxidizers present in this shed and special features for fire suppression and ventilation. Each shed and each compartment within a shed has a separate spill containment reservoir under a fiberglass floor. The sheds are constructed atop a bermed concrete pad with a cover over the main working area of the pad. The pad is sloped to drain away from the covered area to a sanitary sewer pipe with a locked drain.

In April 1992, a DPH site inspector observed numerous problems related primarily to the manner in which the wastes were piled up, the space between waste piles, and the high volume of backlogged waste. In addition, over 100 barrels of unknown material were present at the site. As a result, in June 1992, the HHW Collection Facility was issued a violation of City Ordinance by the Seattle Fire Department for these and other storage- and start-up-related problems.

In October 1992, the DPH requested that a long-range plan for dealing with unknown materials brought to the facility site be submitted. As part of the short-term solution of the storage of unknowns, the facility closed for two weeks in late October and early November so that the backlog could be dealt with and the unknowns cleared out. Subsequently, Burlington Environmental, Inc. was contracted with to test, sort, pack, and dispose of inadequate or non-labeled containers of HHW that had accumulated at the facility.

6.4.2 Cedar Grove Composting Facility

In addition to applying for the facility operating permit issued by the DPW, the Cedar Grove Composting Facility was also required to file a SEPA checklist, apply for a grading permit from the King County Building and Land Development Division, obtain a WDOE stormwater permit, and register the facility and equipment with the Puget Sound Air Pollution Control Agency. The permitting process began in early 1988 with the initial filing of the Application for a Solid Waste Composting Facility permit. The DPH reviewed all data submitted, conducted field surveys of the site, and consulted with the EPA and the State WDOE. The permit was formally issued in January 1989. The Cedar Grove Composting Facility began operation in early 1989 following the receipt of its facility operating permit.

The Cedar Grove facility is subject to the requirements of the Washington Solid Waste Regulations (WAC 173-304) and the King County Board of Health Rules and Regulations (No. 8) for solid waste composting facilities. It is also subject to the general requirements for solid waste handling facilities. These requirements are set forth within the facility permit application (which must include a description of the facility and the types of waste handled, a plan of operation, an inspection schedule and log, and documentation that any on-site wastewater treatment procedures are being or have been reviewed by the WDOE).

In accordance with general requirements, a plan of operation, a closure plan, and a post-closure plan were required to be developed for and abided by the composting facility. Such plans must include a description of waste handling, inspection and monitoring, fire and explosion care, leak detection and corrective action, equipment maintenance, and a safety plan. The closure plan must establish the activities necessary to safely close the facility so as to minimize the need for further maintenance, minimize the threat to human health and the environment, and prepare the facility for post-closure. The closure plan should project the intervals at which partial closure will be implemented and completed and identify closure cost estimates and closure fund withdrawal intervals. The post-closure plan must identify all the post-closure activities necessary to assure that no future threat to human health or the environment will result from past activities at the site.

Local regulations for King County specify that all waste must be stored in a safe and sanitary manner, free of all noise, odor, or vector nuisances. All containers for solid waste storage must be rigid, durable, water tight, corrosion resistant, and vector proof. Yard waste should be managed so as to minimize odors and the generation of excess waste.

The permit for the composting facility requires that compost leachate monitoring be performed on a monthly basis. Each month, representative samples of leachate from the Retention Basin and the Detention Basin must be collected and sampled for the following parameters: pH, temperature, conductivity, chloride, nitrate, nitrite, and nitrogen as ammonia, chemical oxygen demand, total organic carbon, total dissolved solids, and soluble metals analysis (including copper, nickel, zinc, lead, cadmium, arsenic, iron, and manganese). In addition, the following parameters must be analyzed for on a quarterly basis: endrin, lindane, methoxychlor, toxaphene, and 2,4-D and 2,4,5-TP Silvex. These results must then be filed with the DPH.

The permit for this facility also includes requirements for the development and maintenance of a compost inventory control program. A plan for monitoring the volume of compost inventory therefore had to be developed, including the procedures to be used to measure the volume of

compost produced and procedures for recording the volumes removed from the site. The permit establishes a compost inventory limit of 250,000 cubic yards. An annual report must be submitted to verify the volume of compost stored at the facility. The permit stipulates that only the following materials are acceptable for composting at the facility: grass clippings, leaves, brush, prunings, non-treated wood waste, and clean dirt.

After consultation with the EPA, it was deemed necessary that the facility magnetically survey the central and southeast portions of the compost site to determine whether any waste materials were buried in these areas. The survey was required as part of the permitting process and had to be submitted to and approved by the EPA prior to the commencement of operations in those areas of the facility.

The facility has independent systems for both fresh and waste water. Included are separate systems for drinking water, irrigation, and fire control, plus two separate drainage systems. One controls storm and surface water, while the other drains active processing and composting areas into an independent 1.5-million-gallon sedimentation and treatment area. The stormwater treatment system consists of a lined pond to which all three yard waste collection areas drain. The lined pond overflows to a grass pond which overflows, through a restricted orifice, to the adjacent seasonal drainage swale. Water is drawn from the pond system for compost irrigation and dust control. The site is graded to minimize standing water, and silt and settleable solids are captured upstream of the ponds with a silt trap. The two-stage pond system allows for treatment, sedimentation, and re-use of water. Discharge criteria comply with surface water management practices. Biofiltration swales and basins allow for some tertiary biochemical treatment.

In 1990, the Utility contracted with the Sound Resource Management Group to analyze compost quality and environmental parameters. The material was tested for compost maturity, physical characteristics, seed germination, phytotoxicity, pesticide residues, heavy metals, and pathogens. The results showed that the compost met all existing State standards for yard waste composts. One sample did have an arsenic level that was slightly higher than permitted under the State's proposed Class 1 use (10.7 ppm versus 10 ppm). No PCBs were detected, but residues of eight pesticides were found below EPA standards. One result that surprised facility owners was the high level of fecal coliform in the product samples despite the high temperatures maintained within the windrows. It was suggested that the bacteria could have been reintroduced to the finished compost by surface water runoff from the newly windrowed material. Traces of petroleum compounds were also detected in the compost and were believed to have resulted from leakage of diesel fuel and hydraulic fluids by on-site equipment.

The composting facility has had significant problems with odor emissions, resulting in public environmental concerns and complaints. In April 1991, an Analysis of Odors Report was submitted to the DPH by TRC Consultants on behalf of the Cedar Grove Composting Facility. The conclusion of the study was that the major sources of odors were the raw storage piles, ground material storage sites, and some windrows. The consultants suggested that to prevent odors the following actions be taken:

- Minimize residence time of material in storage piles and windrows;
- Keep compost piles well aerated by using scarab at regular intervals; and

- Improve the chemical conditions in the windrows through differential particle sizes, control of moisture content, blending materials, or the addition of chemical additives.

The study concluded that, with respect to expanding facility throughput, the odors produced were caused by specific sources at the site and not related to on-site throughput of material. But odors were determined to be related to storage time, and to the extent that increased throughput would increase storage time, expansion could affect odors.

Based on this study, Cedar Grove drafted a Best Management Practices for Odor Control document and submitted it as part of its permit renewal application in 1991. Additional permit requirements were added to the renewed facility permit as a result. The facility is now required to have all compostibles shredded and windrowed within four days of delivery. Materials are to be aerated twice per week during the first three weeks in windrows and once per week during the last three. The retention and detention basins were required to be equipped with an aeration pumping system. Continuous meteorological monitoring is required at the facility. Cedar Grove was also required to develop an odor complaint tracking and response system and contingency plans for handling complaints and occurrences. The facility was also required to evaluate the odor control potential of alternative feedstock management strategies, including feedstock adjustments, chemical oxidizers, and liquid bacterial solutions.

Odor complaints were substantially reduced in 1991 despite an increase from 59,000 to 75,000 in the tonnage processed. The prevention of odors was the direct result of the quicker processing of incoming materials and quality control measures implemented at collection and transfer operations prior to delivery to the facility. Material handling practices were also altered, including windrow handling, compost detention time, handling frequency, and moisture balancing. In total, nearly $120,000 worth of air emissions and odor mitigation measures were implemented in 1991.

Some odor concerns resurfaced in November 1992 that were believed to be related to the by-product pile. The facility owner proposed moving and covering the by-product pile with an erosion layer. However, the DPH preferred to see a long-term rather than this short-term solution implemented and preferred the permanent removal of waste materials that had accumulated. By the end of FY 1992, the DPH and the facility owner were working to alleviate these odor problems.

6.4.3 Recycle America Materials Recovery Facility

The Recycle America Materials Recovery Facility began operations in 1988. At that time, given the nature and scale of the operation, no solid waste facility permit was required. However, as operations increased, recyclable materials began to be stockpiled outside the facility, and the Recycle America MRF became subject to the waste recycling facility standards (WAC 173-304-300). As mandated by the State code, the regulations and corresponding solid waste permit requirements are activated when recyclable waste regularly accumulates in outdoor piles prior to being processed. A notification by the DPH in March 1992 requested that Recycle America file an application for a Solid Waste Permit and a State SEPA checklist for the MRF. The solid waste permit application and SEPA checklist were submitted on June 5, 1992.

Waste recycling facilities are not subject to the General Requirements for Solid Waste Handling Facilities, but instead are subject to separate and less stringent general requirements for permitting. The facilities' permit applications are required to include a general description of the facility and the types of waste to be handled, an operating plan to include a surface water monitoring plan, and an inspection schedule and log.

Annual reports must also be submitted to the DPH detailing the quantities and types of waste recycled. The facility must comply with air quality standards for odors and dust, and must abide by a surface water program that minimizes runoff from outside storage piles. In addition, the facility operating plan must address litter control, dust and odor control, leak and spill prevention and corrective action, pest control, and surface and groundwater protection.

Surface and groundwater are protected by the Recycle America MRF through the use of two separate drainage systems. Precipitation that has come into contact with unprocessed materials in the outside holding area is discharged into the sanitary sewer system. Discharge into the City system has been authorized by METRO (the Municipal Water and Sewer Authority). The second system drains run-off from the paved parking and driving areas into the stormwater system. An NPDES permit was required for this activity.

After comment and clarification resulting from the WDOE, the DPH issued a Declaration of Non-Significance (DNS) on September 3, 1992, thereby eliminating the need for the filing of a facility environmental impact statement. Comments on the DNS were received from METRO, the Seattle Department of Construction and Land Use, and the WDOE. As a result of the review of the DNS, several issues required addressing by the facility owner. In October 1992, the DPH requested that the facility owner address issues outlined below.

- The three dry wells on the site must be pumped and sealed with a concrete overlay to prevent further percolation of water into the ground.

- Sorting and storing of recyclable materials outside the building may require the facility to update its permit with the Seattle Department of Construction and Land Use.

- The glass pile located to the north of the facility is not included in the application and must be addressed.

- The facility must keep material processed in a timely fashion by abiding by the plan of operation condition to process materials within 24 hours and at a maximum within five days.

These additional issues were addressed, and conditions related to the sealing of the dry wells and monitoring of the glass pile were added to the permit, which was issued on November 20, 1992. No complaints or additional environmental concerns have arisen regarding this facility or its operation since the issuance of this permit.

6.4.4 Rabanco/Recycle Seattle Recycling Center

The Rabanco/Recycle Seattle facility applied for a Solid Waste Recycling Facility Permit on April

30, 1990. As is the case for the Recycle America facility, the Rabanco facility is subject to the waste recycling facility standards (WAC 173-304-300). As such, the facility is not subject to the General Requirements for Solid Waste Handling Facilities, but is instead subject to separate and less stringent general requirements for permitting. The permit application for this facility requires inclusion of a general description of the facility and the types of waste to be handled, an operation plan to include a surface water monitoring plan, and an inspection schedule and log.

Annual reports must be submitted to the DPH detailing the quantities and types of waste recycled. The facility must comply with air quality standards for odors and dust, and must abide by a surface water program that minimizes runoff from outside storage piles. In addition, the facility operating plan must address litter control, dust and odor control, leak and spill prevention and corrective action, pest control, and surface and groundwater protection.

The facility was also required to obtain and comply with the permit conditions of a METRO Waste Discharge Permit. Any violation of the Discharge Permit requirements is also considered a violation of the Solid Waste Handling Permit. The facility also had to obtain a conditional use permit from the Department of Construction and Land Use.

Leachate from wastes at the facility and surface runoff are collected and treated together. On-site drainage is collected at various points and channelled to one of three oil-water separators. The discharge from the separators flow into a sanitary sewer line. The discharge is permitted by METRO discharge permit.

The facility was operated in compliance with its permit requirements in FY 1992.

6.4.5 Columbia Ridge Landfill

The Columbia Ridge Landfill is located in the State of Oregon and, therefore, is required to meet the Oregon Solid Waste Regulations, rather than the Washington State Solid Waste Regulations. The authority to regulate solid waste disposal facilities is granted under the Oregon Solid Waste Control Law, Oregon Revised Statues, Title 36, Chapter 459 (ORS 459.005 through 459.995). Regulations for solid waste facilities are codified as the Oregon Solid Waste Regulations, Oregon Administrative Rules, Chapter 340, Division 61 (OAR 340-61-005 through 340-61-120).

Additional requirements pertaining to landfills govern operating practices with respect to leachate, groundwater protection, surface water protection, monitoring, endangered species, gas control, surface drainage control, floodplains, cover material, cover frequency, access roads, access control, silt screening, fire protection, special handling, signage, truck washing, sewage disposal, salvage, litter, vector control, weighing, and record keeping. Major requirements are discussed below.

Any person designing, constructing, or operating a landfill must ensure that leachate production is minimized and, where required, collected and treated or otherwise controlled. With respect to groundwater, the landfill permittee must ensure that the introduction of any substance from the landfill into an underground drinking water source does not result in a violation of any federal or state drinking water regulation. Additionally, the introduction of any substance from the landfill into an aquifer must not impair the aquifer's beneficial uses. Groundwater monitoring wells might also be required by the Oregon Department of Environmental Quality (DEQ),

depending upon the specific conditions of a proposed landfill site. With respect to surface water, no discharge of pollutants from a landfill into public waters, including wetlands, in violation of any state or federal water quality regulations is allowed. Permittees must ensure that surface runoff and leachate seeps are controlled so as to minimize discharges into public waters.

The concentration of methane gas at a landfill must not exceed twenty-five percent of its lower explosive limit in facility structures or its lower explosive limit at the property boundary. Malodorous decomposition gases must be controlled to prevent public nuisances.

Landfill disposal facilities must also file financial assurance plans assuring that the funds will be available to carry out all closure and post-closure activities. These plans must include written cost estimates of all closure, monitoring, and post-closure activities, a detailed description of the form of the financial assurance, a method and schedule for proving for or accumulating the funds necessary, and a proposal for disposing of any excess moneys received or interest earned on moneys received for financial assurance. The amount required is based on the estimated closure and post-closure care costs. Acceptable financial assurance mechanisms include a closure trust fund established by an entity with authority to act as trustee, a surety bond guaranteeing payment into a closure trust fund, a surety bond guaranteeing performance of closure, an irrevocable letter of credit, a closure insurance policy, or a private corporation meeting the financial test to provide corporate guarantee of closure and post-closure activities.

A landfill facility is also required to submit a closure plan as part of the permitting process. The closure plan must specify the procedures necessary to completely close the land disposal site at the end of its operating life. The plan must also identify the activities which will be carried on after closure to properly monitor and maintain the completed land disposal site. Detailed plans and specifications must be submitted with a description of how and when the facility will be closed. Details should include leachate discharge minimization, landfill gas control, final cover, surface water drainage, and monitoring. Specific requirements for closure include a final cover applied within 60 days of final operation of at least three feet of compact soil of a type approved by the DEQ and graded to a minimum two-percent and maximum 30-percent slope. With respect to post-closure, the facility must operate and maintain leachate and gas collection, removal and treatment systems, and groundwater and surface water monitoring systems.

Oregon Waste Systems, Inc., the owner of the Columbia Ridge Landfill, began initial contacts with the County government and community regarding permitting and environmental issues in mid-1986. A Conditional Use Permit was granted in June 1987 by the County for establishing a landfill in the Exclusive Farm Use Zone. The permit required construction within one year and operation to begin within three years of issuance. The application for the Solid Waste Disposal Facility Permit was filed by Waste Management of North America, Inc.[69] on August 31, 1987. A few missing elements in the original application required some additional submissions. The application was considered complete for processing on November 12, 1987. In addition to the permit application, a number of supporting documents were also submitted. These included a

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[69] Waste Management of North America, Inc. is the parent of Waste Management of Oregon, Inc. In October of 1987, Oregon Waste Systems, Inc. was created by Waste Management of Oregon, Inc. to own and operate the proposed landfill and any other disposal facilities in Oregon.

land use compatibility statement, a feasibility report to the Oregon DEQ on the landfill project, a geologic and hydrogeologic characterization of the proposed landfill site, water quality data and report, laboratory soil testing results, noise and air quality impact analysis, development plans, geological and boring location maps. The DEQ issued its Permit Evaluation Report in January 1988 (making a favorable recommendation for permitting) and a Plan Review Report, to facilitate approval of the plans, in March 1988. The approved solid waste disposal facility permit was issued by the Oregon DEQ on May 18, 1988. Construction was completed at the end of 1989, and the site began receiving waste on January 2, 1990.

In addition to the submission of the application and supporting documents, a number of other requirements had to be fulfilled in order for the permit to be issued. These included: negotiations with the County for assessment of surcharge fees, the establishment of a local Citizens Advisory Committee, certification by the DEQ of local or regional government whose solid waste is to be accepted as having implemented an opportunity to recycle, development of a Waste Reduction Program by local governments proposing to send waste to the landfill, incorporation of the facility into the local solid waste management plan, and a demonstration of the need for the site.

As required by existing regulation and permitting requirements, the major design features of the Columbia Ridge Landfill include: a composite liner system, leachate collection and removal system, leak detection system, gas controls, final cover cap system, optimum landfill grades, large soil stockpile, and extensive erosion control and surface drainage facilities. The bottom liner system consists of a 60-mil HDPE flexible membrane backed up by two feet of clayey soil. These clayey soils are those set aside from the excavation process. A gravel drainage layer above the liner allows any leachate formed to be continuously collected to keep hydraulic head on the liner to no more than one foot. Leachate is pumped or trucked to a basin and held to evaporate.

The facility's permit requires a leachate collection system with collector lines spaced at no more than 300 feet, which drain discrete troughs of a herringbone-type bottom excavation, sized to accommodate remote controlled cameras for inspection of their entire length. The facility's leak detection system consist of secondary leachate collectors running continuously underneath all of the primary leachate collector lines. The system allows each leachate collection trough to be isolated and its performance monitored independently.

All solid wastes are required to be spread into thin layers and thoroughly compacted. The compaction density must meet or exceed an average of 1,200 pounds per cubic yard, in place. All waste is covered with six inches of soil each day. One foot of intermediate soil cover is placed on top of each advancing lift and sloped to shed water. If the immediate cover remains exposed for more than 12 months, it must be seeded with approved vegetation. Final cover is provided as final grades are reached. The final cover design is four feet of soil including one foot of clayey cap. Ditches, cross drains, overside drains, and sedimentation basins are used for control of surface drainage and erosion.

A significant amount of dust is generated through operations at the landfill facility. Air quality standards are complied with through application of water to access roads and through the use of relatively "clean" surface materials on unpaved roads. Air toxics guidelines are complied with by burning landfill gases.

The Columbia Ridge Landfill is subject to a number of monitoring requirements, including daily, monthly, and quarterly testing. On a daily basis, or with each occurrence, the facility must monitor the volume of leachate discharged to the evaporation pond from each sump and the volume of leachate removed from the leak detection system. While leachate is in the evaporation pond, the depth of the liquid must be measured on a daily basis. On a monthly basis, the facility must record the tons of solid waste received, the number of transfer containers handled, the cubic yards of waste received from the public, the number of private vehicles entering the facility, and the percent methane in each gas monitoring well or probe. Quarterly monitoring required includes the types and amounts of salvage or recyclables removed and the static water level in each well. In addition, each monitoring well must be sampled on a quarterly basis for temperature, pH, chloride, and conductivity. The following parameters must be tested for on a quarterly basis for the first year and annually thereafter in the spring: color, dissolved oxygen, total alkalinity, hardness, sulfate, ammonia nitrogen, nitrate-nitrite nitrogen, iron, manganese, calcium, total organic carbon, total organic halogens, chemical oxygen demand, fecal coliform, and enterococcus. Every two years, the facility must test for the priority pollutants outlined in the Code of Federal Regulations (40 CFR 122 App. D).

The landfill is required to provide a place for receiving source-separated recyclable material either at the site or at another location more convenient to the public in the wasteshed where the disposal site is located. Source-separated recyclable material must not be mixed with any other solid wastes brought to the facility and must not be disposed of at the site, but must be reused or recycled.

The facility's permit was renewed without change in 1989 and 1990. However, during late 1990 in preparing for the 1991 permit renewal, the facility applied for a permit modification to include the following changes: a change in the name of the facility to Columbia Ridge Landfill and Recycling Center (from Oregon Waste Systems, Gilliam County Landfill), an extension of the expiration date to mid-1996, inclusion of an additional two modules in the approved fill area, and approval of a back-up solid waste storage cell necessitated by contract conditions between Oregon Waste Systems and the City of Seattle. The facility also requested to be allowed to construct and operate an ash monofill at an agreed-upon location at the existing site. The renewed permit with all the requested modifications was approved and issued on June 10, 1991. The facility is estimated to be receiving well over 100,000 tons of waste per month. Through FY 1992, the compliance history for the site has been characterized as very good.

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Appendix A
Glossary of Terms

Allocated Cost ($/year):	That portion of the Total Cost that is expended or apportioned to a specific activity such as the management of garbage, trash, recyclables, yard waste, or household hazardous waste.
Analyzed MSW:	Portion of the MSW stream for which the cost of collecting, transferring, hauling, processing, combusting, marketing, and/or disposing of such waste is known or can be reasonably estimated.
Average Cost	($/ton):Total or Allocated Cost divided by the tons of MSW, garbage, trash, recyclables, or yard waste, as appropriate.
Average Program Incremental Cost (Savings) ($/ton):	The Program Incremental Cost divided by the number of tons of materials diverted from the landfill by the program.
Bulky Waste:	Oversized items, including white goods and furniture, that have been separated from the MSW stream for separate collection.
Commercial MSW:	Municipal solid waste that is generated by sources other than households, including businesses (e.g., offices, restaurants, retail stores, and industry); institutions (e.g., schools and government establishments); and public areas (e.g., train stations, airports, and litter from roadside).
Garbage:	Garbage is all MSW exclusive of source-separated trash, recyclables, yard waste, household hazardous waste, and bulky waste.

Hazardous Waste:	Waste which because of its quantity, concentration, or physical, chemical, or infectious characteristics, may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed and is defined as such in accordance with federal and State laws. Does not include Household Hazardous Waste.
Household Hazardous Wastes (HHW):	Materials that are separated from Residential MSW as household hazardous wastes for separate collection and treatment. Such materials may include paints and solvents, pesticides, herbicides, and propane tanks.
Integrated Solid Waste Management:	A practice of using several (i.e., two or more) alternative waste management techniques to treat, process, and/or dispose of the Municipal Solid Waste stream. Alternative waste management techniques include source reduction, recycling, composting, combusting, and landfilling.
Marginal Cost (Savings) ($/ton):	The cost (savings) of managing an additional ton of MSW, garbage, trash, recyclables, or yard waste.
Marginal Cost (Savings) of Substitution ($/ton):	The net cost (savings) of managing an additional ton of recyclables or yard waste less the savings (cost) of managing one less ton of garbage.
Materials Recovery:	A term describing the extraction and utilization of materials from a waste stream.
Municipal Solid Waste (MSW):	Non-hazardous solid wastes generated by households, commercial and business establishments, institutions, and light industry; it excludes industrial process wastes, agricultural wastes, mining wastes,

	construction and demolition debris, offal, sludges, and ashes, except ashes derived from the combustion of MSW. In practice, specific definitions vary across jurisdictions.
Program Incremental Cost (Savings) ($/year):	The difference between the cost of managing MSW with or without a particular program (e.g., curbside collection, processing, and marketing of recyclables.)
Recovered Materials:	Recyclable materials that are recovered from MSW and may also include some contamination.
Recyclable Materials or Recyclables:	Materials that still have useful physical or chemical properties after serving their usefulness for a given individual or firm and can, therefore, be reused or recycled for the same or other purposes.
Recycle:	To convert discarded materials into useful products through reuse and remanufacturing.
Residential MSW:	Municipal solid waste that is generated by households.
Residue:	That portion of processed MSW that is ultimately disposed of in a landfill.
Resource Recovery:	A term describing the extraction and utilization of energy or materials from a waste stream.
Secondary Material:	A material that is used in place of a primary or raw material in manufacturing a product; often handled by dealers and brokers in "secondary markets."

Appendix B
Allocation of Costs and Result Tables

The allocation procedures used to determine the cost incurred for various functions or types of waste are presented in this Appendix. The procedure involves the following steps: (1) classification of each expenditure by function; (2) determination of expenditures that are totally or partially "applicable" or "not applicable" to the 232,000 tons of Managed MSW; (3) allocation of expenditures related to the management of garbage, yard waste, and recyclables constituting Managed MSW; and (4) allocation of Utility costs to manage HHW. Each of these steps is discussed below. The resulting allocations of the total cost of $72.3 million (see Appendix C) are provided in Tables B.1 through B.15 at the end of this Appendix.

B.1 Step 1: Classification of Expenditures by Function

The expenditures incurred by the Utility were classified into the following functional areas: General & Administrative (G&A); Taxes; Collection/Processing; Transfer; Transport and Haul; Rail Haul/Landfill; Promotion, Education, and Public Relations; Miscellaneous Recycling Expenses; Capital Expenses; Litter Control; Other Wastes; and Landfill Closure.

B.2 Step 2: Determination of "Applicable" and "Not Applicable" Expenses

About $36.3 million of the $72.3 million total cost is classified as being "not applicable" to the management of the 232,000 tons of Managed MSW. The Managed MSW is that portion of the MSW managed by the Utility for which collection, transfer, haul, processing, and disposal costs were calculated.

The $36.3 million represents costs to: (1) manage Other Waste (e.g., C&D debris and tires); (2) manage the approximately 308,000 tons of self-hauled, waste, including litter, for which collection costs are not known; and (3) close the Kent-Highland and Midway landfills. These latter expenses are appropriately allocated to the cost of managing waste generated prior to FY 1992. Of the $36.3 million allocated to "not applicable," $8.12 million, or 22 percent, was expended for landfill closure, and $12.8 million, or 35 percent, was expended for rail-haul and disposal of self-hauled garbage.

Each expense in Tables B.2 through B.14 was first reviewed to determine whether it could be classified as being either "applicable" or "not applicable." For example, 100 percent of the "Garbage" collection costs in Table B.4 are applicable to the management of the 232,000 tons of Managed MSW. On the other hand, 100 percent of the "Waste Reduction" costs in Table B.8 or the "Recycling Operation" in Table B.5 are classified as "not applicable."

The footnotes in Tables B.2 through B.14 describe the methods used to determine the portion of other expenses that are not applicable to the management of the 232,000 tons of Managed MSW. Generally, tonnage figures are used to apportion costs.

For example, consider the $126,927 yard waste transfer station "Operations" cost in Table B.5. Of the total 35,676 tons of yard waste processed at the transfer stations, 11,129 tons were self-hauled, i.e., are not included in the 232,000 tons of Managed MSW. Multiplying the $126,927 cost by the ratio of 11,129 to 35,676 results in the $39,594 cost that is not applicable to the 232,000 tons of Managed MSW.

B.3 Step 3: Allocation of Managed MSW Costs by Type of Waste

The procedure to allocate the $34.4 million cost to manage the 232,000 tons of Managed MSW to the cost of managing garbage, recyclables, or yard waste is similar to the procedure used to determine which costs or proportions of costs were "applicable" or "not applicable." The footnotes in Tables B.2 through B.14 describe the variables used to determine the portion of these costs apportioned to garbage, recyclables, and yard waste. First, specific costs that are either 100-percent associated with the management of either garbage, recyclables, or yard waste were identified and allocated accordingly. Generally, all non-G&A and non-tax expenses are allocated based on tonnage, and G&A expenses and taxes are allocated in direct proportion to the allocation of other costs.

B.4 Step 4: Allocation of Costs to Manage HHW

The cost that can be 100-percent attributed to the HHW activities were allocated to the management of HHW. For example, the HHW Promotion/Education expenses reported in Table B.8 were allocated to the cost of managing HHW. G&A expenses and taxes that are not 100-percent attributed to the HHW were allocated to HHW in direct proportion to other costs that were allocated to the management of HHW.

TABLE B.1: SEATTLE'S INTEGRATED MUNICIPAL SOLID WASTE MANAGEMENT COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
General & Administrative	$8,404,106	$4,256,284	$3,958,074	$2,832,700	$590,014	$535,360	$189,748
Taxes	0	0		0	0	0	0
Collection/Processing	16,882,722	197,541	15,700,063	9,428,429	3,384,824	2,886,810	985,119
Transfer	4,056,717	1,966,989	2,089,728	1,817,577		272,151	
Transport & Hauling	976,988	441,670	535,318	356,098		179,220	
Facilities (Included Above)							
Railhaul/Landfill	19,074,044	12,823,118	6,250,926	6,250,926			
Promotion/Education/PR	692,849	344,308	269,107	31,507	172,162	65,438	79,434
Misc. Recycling Expenses	1,481,235	998,343	369,405	38,262	273,072	58,071	113,486
Capital Expenses	2,373,767	1,288,267	1,060,692	873,457	89,652	97,583	24,808
Interest	(inc.)		0				
Litter Control	1,966,959	1,966,959	0				
Other Wastes	199,940	149,208	0				50,732
Landfill Closure (inc. int. & dep.)	8,174,428	8,174,428	0				
TOTAL	$64,283,755	$32,607,114	$30,233,313	$21,628,956	$4,509,724	$4,094,634	$1,443,327
COST PER TON ($/ton)			131	152	88	119	

NOTES:

1. Costs incurred for activities other than those related to Analyzed MSW are either allocated to "HHW" or "Not Applicable", as appropriate.
2. The $8.2 million State and City Business and Occupancy Taxed charge to the Ratepayers by the Utility are treated as transfer payment rather than costs in this analysis.

SOURCES:

1. "Solid Waste Utility Income Statement", Final Audit, May 7, 1993.
2. "Seattle Solid Waste Utility Detailed Expense Distribution", pre-audit version.
3. "Distribution of Capital Expenditures", pre-audit version.
4. Monthly invoices from General Disposal, U.S. Disposal, Recycle America, Recycle Seattle, and Washington Waste Systems.
5. Conversations with S. Viney, Director of Rates, Seattle Solid Waste Utility.
6. Conversation with N. Pealy, Director, Strategic Planning, Finance, and Information Systems, Seattle Solid Waste Utility.

ALLOCATION OF COSTS: See Tables B2 through B14.

TABLE B.2: GENERAL AND ADMINISTRATION COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
General & Administrative	$3,810,307	$1,929,741	$1,794,537	$1,284,308	$267,504	$242,725	$86,029
Billing and Collecting	4,593,799	2,326,543	2,163,537	1,548,393	322,510	292,635	103,719
TOTAL	$8,404,106	$4,256,284	$3,958,074	$2,832,700	$590,014	$535,360	$189,748

ALLOCATION OF COSTS:

Allocations are based upon the percentage of non-G&A and tax expenses.

TABLE B.3: TAXES (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
City Bus. & Occup. Tax	$5,824,092	$2,954,883	$2,738,554	$1,959,052	$408,534	$370,968	$130,655
State Bus. & Occup. Tax	2,409,231	1,222,336	1,132,848	810,394	168,997	153,457	54,048
TOTAL	$8,233,324	$4,177,220	$3,871,401	$2,769,446	$577,531	$524,424	$184,703

ALLOCATION OF COSTS:

1. The allocation of the City and State taxes is based upon the allocated costs, exclusive of these taxes, i.e., the taxes are allocated in direct proportion to all other costs.
2. Because state and city taxing and pricing policies promote waste reduction and recycling, the taxes are actually applied in much greater proportion to garbage, a lesser to extent yard waste, and none for recyclables. However, if prices for the services provided by the SWU were cost based and taxes revenue based, then the tax calculations would approximate the allocations used in this analysis.
3. Taxes are viewed by economists as transfer payments rather than costs. Because the revenues raised from these taxes are not dedicated to MSW managaement, they are treated as transfer payments in this analysis.

TABLE B.4: COLLECTION COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Garbage/North/General Disposa	$6,032,166		$6,032,166	$6,032,166			
Garbage/South/U.S. Disposal	3,295,558		3,295,558	3,295,558			
Garbage/Cont. Adm.	89,614		89,614	89,614			
Garbage/Misc.	11,091		11,091	11,091			
Yard Waste/North/Gen. Disposa	1,532,008		1,532,008			1,532,008	
Yard Waste/South/U.S. Disposa	1,405,134	139,113	1,266,022			1,266,022	
Yard Waste/Cont. Administratior	88,780		88,780			88,780	
Recycle/North/Recycle America	1,481,046		1,481,046		1,481,046		
Recycle/South/Recycle Seattle	1,540,160		1,540,160		1,540,160		
Recycle/Cont. Adm.	31,078		31,078		31,078		
Recycle/W. Seattle Pay.	22,811		22,811		22,811		
Recycle/Apartment	234,605		234,605		234,605		
White Goods	75,125	0	75,125		75,125		
HHW South Operations	985,119		0				985,119
Purchase of Compost	58,428	58,428	0				
TOTAL	$16,882,722	$197,541	$15,700,063	$9,428,429	$3,384,824	$2,886,810	$985,119

ALLOCATION OF COSTS:

1. The collection contracts for U.S. Disposal and General Disposal have separate pricing provisions for the collection and recycling of white goods. The cost of the collection and disposition of white goods was obtained from the monthly invoices of each firm. The garbage collection costs for each firm were reduced by the cost of white good collection/disposition and the "White Goods" cost was increased by this amount.
2. The collection contracts have provisions for the contractor to run promotional/educational activities. The costs of these programs, as determined by the monthly invoices, were reduced from the collection costs and added to the "Promontion/Education/Public Relations" costs in Table B10.

TABLE B.5: TRANSFER COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Garbage Operations	$982,375	$399,121	$583,254	$583,254			
Yard Waste Operations	126,927	39,594	87,332			87,332	
Recycling Operations	192,485	192,485	0		0		
General/Misc. Expenses	2,754,931	1,335,789	1,419,142	1,234,323	0	184,819	
less forbidden waste promo							
TOTAL	$4,056,717	$1,966,989	$2,089,728	$1,817,577	$0	$272,151	$0

ALLOCATION OF COSTS:

1. The allocation of the "Garbage Operations" cost between "Not Applicable" and "Garbage" is based upon the proportion of self-hauled garbage to contractor-delivered garbage at the transfer stations (see Table 3-1).
2. The allocation of the "Yard Waste Operations" cost between "Not Applicable" and "Yard Waste" is based upon the proportion of self-hauled yard waste to contractor-delivered yard waste at the transfer stations (see Table 3-1).
3. "Recycling Operations" costs are allocated to "Not Applicable" because all recyclables delivered to the transfer stations are self-hauled.
4. "General/Misc. Expenses" are allocated in direct proportion to operating costs at the transfer station.

TABLE B.6: TRANSPORT & HAULING COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Garbage Hauling	$331,560	$134,707	$196,853	$196,853			
Recyclables Hauling	63,187	63,187	0		0		
Yard Waste Hauling	143,992	44,918	99,074			99,074	
Misc.							
Equipment	278,675	125,600	153,075	101,827	0	51,248	
Misc. Expenses	67,843	30,577	37,266	24,790	0	12,476	
Other Waste	2,436	2,436	0				
MTCE:Chassis	10,460	4,714	5,746	3,822	0	1,924	
MTCE:Trailers	35,246	15,885	19,360	12,879	0	6,482	
OPS:Light Duty Work	43,589	19,646	23,943	15,927	0	8,016	
TOTAL	$976,988	$441,670	$535,318	$356,098	$0	$179,220	$0

ALLOCATION OF COSTS:

1. The allocation of the "Garbage Hauling" cost between "Not Applicable" and "Garbage" is based upon the proportion of self-hauled garbage to contractor-delivered garbage at the transfer stations (see Table 3-1).
2. The allocation of the "Yard Waste Hauling" cost between "Not Applicable" and "Yard Waste" is based upon the proportion of self-hauled yard waste to contractor-delivered yard waste at the transfer stations (see Table 3-1).
3. "Recycling Hauling" costs are allocated to "Not Applicable" because all recyclables delivered to the transfer stations are self-hauled.
4. "Misc." costs, except for "Other Waste", are allocated in direct proportion to hauling costs at the transfer station. "Other Waste" is allocated as "Not Applicable."

TABLE B.7: RAILHAUL AND LANDFILL COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
WMI Contract Payments	$18,963,887	$12,749,062	$6,214,825	$6,214,825			
Contract Administration	109,382	73,536	35,847	35,847			
Contract Implementation	775	521	254	254			
TOTAL	$19,074,044	$12,823,118	$6,250,926	$6,250,926	$0	$0	$0

ALLOCATION OF COSTS:

1. The cost of railhaul and landfilling of garbage that is delivered to the railhead by private firms is allocated to "Not Applicable."
2. Garbage that is self-hauled to the transfer stations is not included in the definition of Analyzed MSW, therefore, 100% of the cost of railhaul and landfilling of the self-hauled garbage is allocated to "Not Applicable."

TABLE B.8: PROMOTION/EDUCATION/PUBLIC RELATIONS COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Waste Reduct. & Education	$49,302	$49,302	$0				
SWU-Comm. Affairs Div.	38,008	18,888	14,763	1,728	9,444	3,590	4,358
Other Promotion/Ed	19,028	9,456	7,391	865	4,728	1,797	2,182
School Outreach	153,335	76,199	59,556	6,973	38,101	14,482	17,580
HHW Promotion	7		0				7
Curbside Recycling	55,566		55,566		55,566		
Plastic Dropoff	1,097	1,097	0		0		
YW Kraft Bag	312		312			312	
YW Curb	30,954		30,954			30,954	
U.S. Disp. YW Publicity	14,303		14,303			14,303	
U.S. Disposal Promo & Ed	10,000		10,000	10,000			
Forbidden Waste	3,364		3,364	3,364			
Curbside Garbage Promo	8,576		8,576	8,576			
Apartment Recycling	63,768		63,768		63,768		
City Dept. Promo	554		554		554		
Waste EAP Reduction	2,556	2,556	0				
Waste Reduction Directory	22,856	22,856	0				
Waste Reduction Survey	10,000	10,000	0				
Retail Waste Reduction	76,813	76,813	0				
HHW Education	11,415		0				11,415
HHW Reduction	77,142	77,142	0				
Motor Oil Recycling	21,733		0				21,733
HHW Promotion/Education	22,161		0				22,161
TOTAL	$692,849	$344,308	$269,107	$31,507	$172,162	$65,438	$79,434

ALLOCATION OF COSTS:

1. All "Waste Reduction" activities are allocated to "Not Applicable."
2. "SWU-Comm. Affairs Div.", "Other Promotion/Ed", and "School Outreach" are allocated in direct proportion to the allocation of all the other Promotion/Education/Public Relation costs.

TABLE B.9: MISC. RECYCLING AND PLANNING EXPENSES (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Misc. Expense Waste R&R	($445)	($445)	$0				
Recruting	20,775	2,032	18,742		18,742		
Solid Waste Adv. Comm.	14,089	8,044	6,024	3,699	1,421	905	21
Environmental Allow Prog.	114,578	114,578	0		0		
Apartment Recycling Plan	98,153	9,601	88,552		88,552		
City Depart. Recycling	27,618	27,618	0		0		
Waste Stream Projections	87,704	43,852	43,852		43,852		
Legislation	12,368	7,062	5,289	3,247	1,247	795	18
Market Development	66,398	6,495	59,903		59,903		
Other Recycling Planning	0	0			0		
Other SW Services Planning	0	0			0		
Special Cont. Monitoring	41	0	(0)				41
Backyard Compost Program	109,851	109,851	0				
Private Recycling	61,631	61,631	0				
Friends of Recycling	83,591	47,725	35,742	21,944	8,428	5,370	123
Yard Waste Processing	207	50	157			157	
Overall Yard Waste	44,152	10,701	33,451			33,451	
Plastics General	20,360	1,992	18,369		18,369		
Plastics-Dropbox	3,619	3,619	0		0		
Diaper Recycling Exp.	2,468	2,468	0		0		
Commercial Recycling	145,135	145,135	0				
Waste Stream Composition	51,099	25,550	25,550		25,550		
EPA Recycle Document Grant	28,456	16,247	12,168	7,470	2,869	1,828	42
DOE Waste Reduction Grant	3,123	3,123	0				
Waste Reduction Plan	1,032	1,032	0				
Rates/Recycling Support	307	30	277		277		
Payments for Mixed Paper	587	57	530		530		
Mowry Baden Project	2,884	282	2,602		2,602		
Compost Quality Assurance	18,272	4,428	13,843			13,843	
Business & Ind. Recycling	761	761	0				
Supervision PDT Staff	6,304	3,599	2,695	1,655	636	405	9
Co-Compost Study	1,392	136	1,255			1,255	
School Grant EPA	1,942	1,109	830	510	196	125	3
CPG-Backyard Composting	234,686	234,686	0				
CPG-BIRV	84,771	84,771	0				
HHW-Reimbursement	(1,103,707)		0				(1,103,707)
HHW-Program Devel.	63,710		0				63,710
HHW-Local Plan	28,122		0				28,122
HHW-North Development	18,994		0				18,994
HHW-Local Planning Fund	1,124,799	21,092	0				1,103,707
HHW-South Facility	2,404		0				2,404
Other (Reconcile)	(996)	(569)	(426)	(261)	(100)	(64)	(1)
TOTAL	$1,481,235	$998,343	$369,405	$38,262	$273,072	$58,071	$113,486

ALLOCATION OF COSTS:

1. Allocations based on a discussion with N. Pealy, Director, Strategic Planning, Finance, and Information Systems.
2. "Waste Reduction", "Backyard Composting", and "Commercial/Private Recycling" is allocated to "Not Applicable."
3. The "Solid Waste Adv. Comm.", "Legislation", "Friends of Recycling", "EPA Recycle Document Grant", "Supervision PDT Staff", "School Grant EPA", and "Other (Reconcile)" expenses are allocated based on tonnage (per conversation with N. Pealy, SWU).
4. In FY92 the City contributed $1,124,799 to the state's "Local Planning Fund" and received a $1,103,707 reimbursement. The balance of $21,092 was dispersed to other communities. This reflects a transfer cost and is, therefore, allocated to "Not Applicable."
5. Half of the "Waste Stream Projection" and "Waste Stream Composition" expenses were allocated to "Not Applicable" because these studies were used to support commercial recycling programs (per conversation with N. Pealy, SWU)
6. Other Recycling or Yard Waste expenses that are allocted to "Not Applicable" are based upon the percentage of Recyclables or Yard Waste, as appropriate, that are self-hauled or contractor-delivered to the transfer station.

TABLE B.10: CAPITAL COSTS (FY92)

Annual Capital Cost

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Landfill Closure	$3,179,009	$3,179,009	$0				
Non-Landfill Closure							
Other Capital Costs	$882,992	$305,651	$562,127	$466,133	$55,464	$40,530	$15,213
1992 Capital Outlays	221,405	142,355	75,516	59,354	2,608	13,555	3,534
Compactors at TFS	219,589	89,215	130,374	130,374			
Hauling Equipment	267,284	108,530	158,754	135,377		23,377	
Recycling Equipment	463,697	463,697	0		0		
Compactor Ram Replacement	0	0		0			
Haller Lake Side/Curb	5,600		0				5,600
Planning	313,200	178,818	133,920	82,219	31,579	20,122	462
Subtotal Non-Landfill Closure	$2,373,767	$1,288,267	$1,060,692	$873,457	$89,652	$97,583	$24,808
TOTAL	$5,558,376	$4,467,276	$1,060,692	$873,457	$89,652	$97,583	$24,808

ALLOCATION OF COSTS:

1. "Balance" and "Hauling Equipment" costs are allocted to "Not Applicable", "Garbage", "Recyclables", and "Yard Waste" based upon percentage of garbage or yard waste, as approprate, that is self-hauled and the percentage that is contractor-delivered to the transfer stations (see Table 3-1).
2. The "Compactor" related capital costs are allocated based upon percentage of garbage that is self-hauled and the percentage of contractor-delivered garbage at the transfer stations (see Table 3-1).

SOURCES:

1. City of Seattle, "Distribution of Capital Expenditures Summary", 12/92.
2. Converstions with S. Viney, Seattle Solid Waste Utility, June 1993.
3. Institute for Local Self-Reliance, "Recycling and Composting Programs:Designs, Costs, Results", Volume III: Urban Areas, Seattle, Washington, page 183.

TABLE B.11: INTEREST (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Interest on Bonds	$3,620,224	$3,620,224	$0				
Amortized Financing Costs	129,932	129,932	0				
TOTAL	$3,750,156	$3,750,156	$0	$0	$0	$0	$0

NOTE:

All interest costs are related to Bonds issued for the landfill closures.

TABLE B.12: LANDFILL CLOSURE COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Landfill Closure Operations	$1,245,263	$1,245,263	$0				
TOTAL	$1,245,263	$1,245,263	$0	$0	$0	$0	$0

TABLE B.13: LITTER CONTROL COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Litter Control	$1,966,959	$1,966,959	$0				
TOTAL	$1,966,959	$1,966,959	$0	$0	$0	$0	$0

NOTE:
The quantity of litter collected by the City is included in the self-hauled tonnage, but the actual tonnage is unknown.

TABLE B.14: OTHER WASTE COSTS (FY92)

COSTS	TOTAL	NOT APPLICABLE	ANALYZED MSW	GARBAGE	RECYCLABLES	YARD WASTE	HHW
Infectious Wastes	$49,069	$49,069	$0				
Other Special Wastes	46,994	46,994	0				
Demolition Wastes	4,386	4,386	0				
Used Oil Recycling	46,079		0				46,079
Oil Recycling Operation/NTFS	1,656		0				1,656
Oil Recycling Operation/STFS	2,997		0				2,997
Wood Waste Site Direct Cost	33,478	33,478	0				
Tire Disposal	14,747	14,747	0				
Wood Waste Recycling Plan	534	534	0				
TOTAL	$199,940	$149,208	$0	$0	$0	$0	$50,732

NOTE:

Seattle's HHW program includes the collection of used oil.

TABLE B.15: ALLOCATION OF SEATTLE'S SOLID WASTE UTILITY'S COSTS (FY92)

COST	Analyzed MSW	HHW	Self-Haul to TFS	Landfill Closure	Self-Haul to Railhead	Litter Control	Waste Reduction	Other Wastes	Misc.	Total
Administrative/Management	$3,958,074	$189,748	$1,672,242	$877,713	$317,771	$314,514	$345,965	$728,078		$8,404,106
Taxes	0	0	0	0	0	0	0	0		0
Collection/Processing	15,700,063	985,119	197,541							16,882,722
Transfer	2,089,728		1,966,989							4,056,717
Transport & Hauling	535,318		441,670							976,988
Facilities (Included Above)			0							0
Railhaul/Landfill	6,250,926		4,277,509		8,545,609					19,074,044
Promotion/Education/PR	269,107	79,434	1,430				342,879			692,849
Misc. Recycling Expenses	369,405	113,486	339,829				637,422		21,092	1,481,235
Capital Expenses	1,060,692	24,808	1,288,267							2,373,767
Interest	0		0							0
Litter Control	0		0			1,966,959				1,966,959
Other Wastes	0	50,732	(0)					149,208		199,940
Landfill Closure (inc. int. & dep.)	0		0	8,174,428						8,174,428
TOTAL	$30,233,313	$1,443,327	$10,185,476	$9,052,141	$8,863,379	$2,281,473	$1,326,266	$877,286	$21,092	$64,283,755
PERCENT OF TOTAL	47.03%	2.25%	15.84%	14.08%	13.79%	3.55%	2.06%	1.36%	0.03%	100.00%

Appendix C
Methodology, Assumptions, and Data Used to Calculate Marginal Costs and Program Incremental Costs

C.1 Marginal Costs

The methodology, assumptions, and data used to calculate the Marginal Costs to manage garbage, recyclables, and yard waste are presented below.

C.1.1 Marginal Cost to Manage Garbage

To calculate the Marginal Cost to manage garbage, the Marginal Costs of collection, transfer, rail haul, and disposal must be considered, as discussed below.

C.1.1.1 Garbage Collection Marginal Cost

General Disposal and U.S. Disposal are paid to collect the garbage and deliver it to the North and South Transfer Stations, respectively. Both contractors perform many services in addition to collecting garbage, such as to "monitor and collect extra refuse that contains a City of Seattle supplied sticker; collect bulky items and major appliances; supply wheeled containers to structures presently receiving can service for use in semi-automated curbside/alley collection; supply detachable containers to multi-unit residential buildings; provide backyard collection service for people who are either disabled or who pay the City an additional charge; provide special collection services; and collect yard waste."[70]

Separate fees are charged for garbage collection, yard waste collection, and the other services provided by the contractor. The garbage collection fee is divided into two parts: a Structure Price and a Tonnage Price.[71] The Structure Price is a function of the number of buildings with five or more dwelling units and is independent of the tonnage collected. Similarly, the other fees collected for providing special services such as supplying containers or providing backyard services are also independent of small changes in tonnage.

Only the Tonnage Price is affected by small changes in tonnage, as follows. The Tonnage Price is adjusted annually in direct proportion to increases or decreases in the quantity of garbage collected. (In addition, it is adjusted to reflect changes in the Consumer Price Index, i.e., CPI.) Therefore, the actual expense for collecting more garbage in any year is delayed until the adjustment in the Tonnage Price occurs and payments are made in the subsequent year. Theoretically, the payment for additional tonnage should be discounted to account for the time value of money during this delay. For the sake of simplicity, in this analysis such discounting of future payments has not been performed. The effect is to slightly overstate the Marginal Cost of collection of garbage and slightly underestimate the Marginal Cost of Substitution.

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[70] "Solid Waste and Yard Waste Collection Contract," City of Seattle and General Disposal Corp., January 1, 1989 - March 31, 1996, page 1, and "Solid Waste and Yard Waste Collection Contract," City of Seattle and U.S. Disposal, January 1, 1989 - March 31, 1996, page 1.

[71] For example, see "Solid Waste and Yard Waste Collection Contract," City of Seattle and General Disposal Corp., January 1, 1989 - March 31, 1996, page 42.

Table C.1 shows that in FY 1992 General Disposal received, exclusive of payments for yard waste and bulky waste collections, $6,028,929, of which $2,836,124 was the Tonnage Price.[72] Since the number of tons of garbage collected by General Disposal in FY 1992 was 96,679, the Marginal Cost of collection was $29.34 per ton (i.e., 2,836,124 divided by 96,679).[73]

Total garbage collection costs for FY 1992 can be expressed symbolically as:

$$TC = 29.34(T) + 3,192,805,$$

where

TC = total costs ($/year); and
T = tons collected (tons/year).

This equation is a linear cost equation consisting of a variable portion (i.e., that portion of cost that is a function of tonnage) and a fixed portion. In the above equation, the $3,192,805 is the fixed portion. The fixed costs actually change over time based on many factors, such as the change in the Consumer Price Index, changes in the number of large multi-family structures, and the number of customers requesting special services. These costs are considered fixed because for short periods of time and small changes in tonnage they are not affected by the quantity of garbage collected.

Although the collection cost equation is the **price** charged to the Utility by General Disposal, it illustrates that **costs** consist of both variable and fixed components. The fixed cost component of collection includes G&A, capital costs, and base labor costs (base staffing levels usually do not change with tons collected). Variable costs may include fuel, variable labor (for example, overtime), and vehicle maintenance costs.[74]

Similarly, Table C.2 shows the fees received by U.S. Disposal in FY 1992. U.S. Disposal received, exclusive of the fees for the collection of yard waste and bulky waste, $3,233,882 for the collection of 45,475 tons of garbage. Given that the Tonnage Price was $1,543,942, the Marginal Cost for collection in the southern sector was $33.95 (i.e., $1,543,942 divided by 45,475).

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[72] "Seattle Solid Waste Utility Detailed Expense Distribution," and "Monthly Payment Authorization."

[73] Because the cost curve is linear the average Tonnage Price is equal to the marginal cost.

[74] The fixed and variable prices charge by General Disposal reflect competitive market prices for the form and type of services procured by the SWU and may not reflect General Disposal's actual fixed and variable costs. However, total revenues earned by General Disposal most likely exceed its total costs.

C.1.1.2 Transfer Station Marginal Cost

Because the changes in tons managed to calculate Marginal Costs by definition are small, it is assumed that there is no additional costs or savings at the transfer stations. Specifically, it is assumed that no additional people will be required to operate and maintain the transfer stations. Similarly, it is assumed that no additional equipment is needed. Addition fuel consumption is assumed to be minimal.[75]

The key to these assumptions is that the changes in tonnage are small. This is the essence of a Marginal Cost calculation. At some point increasing the tonnage handled at the transfer stations will require the purchase of new equipment, the hiring of additional personnel, or the use of overtime. The Marginal Cost analysis assumes that such changes are not required for small increases in tonnage.[76]

C.1.1.3 Marginal Cost of Haul and Disposal

For every ton of garbage delivered to the Union Pacific railhead, Washington Waste System was paid $43.22. In addition, a $0.50 per-ton tax was paid to the state of Oregon.[77] Because the contract provides for a per-ton fee for rail-haul and disposal, both the Average Cost and Marginal Cost to the Utility are equal to $43.72 per ton.

This does not imply that there are no fixed costs to Washington Waste Systems. Quite the contrary. The capital investment in the rail haul system and the development of the landfill, the base labor cost, and G&A expenses are all independent of tonnage and thus are fixed costs. Rather than paying a fixed and variable fee, as was done in the collection contracts to ensure coverage of fixed costs, the contract between the Utility and Washington Waste Systems has a minimum term of 10 years and requires the City to direct all of the garbage collected in Seattle to the Washington Waste Systems system (i.e., flow control).[78] Thus, Washington Waste Systems has a reasonable expectation that sufficient tonnage will be delivered to its facility over a long enough time period to cover its total cost, (i.e., fixed and variable costs, including its expected return on investment will be covered).

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[75] Each one ton annual increase in garbage collection results in less than an 8 pound per day (i.e., 2,000 divided by 260) average increase in the amount of garbage handled at the transfer stations.

[76] In the long run savings may occur with decreases in tonnage by retiring equipment or reducing staff levels.

[77] Because it is purported that this tax is used to monitor and enforce environmental compliance of the landfill, this tax is included in the cost of garbage disposal rather than a transfer payment.

[78] "Contract Between the City of Seattle and Washington Waste Systems, Inc. for the Transportation and Disposal of Waste," Section 10. Length of Contract, page 1 and Section 30(i). City Responsibilities, page 6.

The point here is that although the contract only specifies a per-ton fee, the underlying cost structure still has fixed and variable components. Should significant changes in tonnage occur, then average costs would also change significantly. In fact, the price structure for the rail-haul system already provides for quantity discounts as the tonnage disposed of increases, as shown in Table C.3. This quantity discount, in part, reflects a decrease in the average cost to Washington Waste Systems in providing this service as tonnage increases.

C.1.1.4 Utility Marginal G&A Expenses

There is no reason to believe that small increases or decreases in the tons of garbage collected will affect the Utility's G&A expense. Therefore, there is no Marginal G&A Cost.

C.1.1.5 Marginal Cost of Managing Garbage

The Marginal Cost of managing garbage in the northern sector is about $73 per ton, which is the sum of the Marginal Costs of collection, transfer, haul, disposal, and Utility G&A (i.e., $29.34 plus 0 plus $43.72 plus 0, respectively).

The Marginal Cost of managing garbage in the southern sector is about $78 per ton, which is the sum of the Marginal Costs of collection, transfer, haul, disposal, and Utility G&A (i.e., $33.95 plus 0 plus $43.72 plus 0, respectively).

C.1.2 Marginal Cost to Manage Recyclables

Recycle America was paid a per-ton fee for the collection, processing, and marketing of recyclables.[79] In December 1992, the fee paid to Recycle America was $110.01 per ton for plastics and $56.56 for other recyclables. The weighted average fee was $56.95.[80,81] Recycle America was paid this amount for each ton it collected; therefore, for small changes in tonnage, this fee represents the Marginal Cost to manage recyclables in the northern sector.

Recycle Seattle was paid a per-ton fee for the collection, processing, and marketing of recyclables. In addition, the payments made are adjusted for changes in the market price of recyclables.[82] The total fee paid Recycle Seattle in FY 1992 was $1,540,160 (see Table B.4 of Appendix B). The average fee paid to Recycle Seattle was about $67.52 per ton (i.e., the total

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[79] "Home Collection of Source Separated Recyclable Material Contact," City of Seattle and Recycle America, page 12.

[80] Monthly invoice for services provided by Recycle America, January 4, 1993.

[81] The per ton fee charged by Recycle America was adjusted for inflation early in FY 92. The December rates were applied for most of the year.

[82] "Home Collection of Source Separated Recyclable Material Contact," City of Seattle and Recycle Seattle, page 12 and 13.

fees of $1,540,160 divided by 22,812).[83] Recycle Seattle was paid this amount for each ton it collected, therefore, for small changes in tonnage, this fee represents the Marginal Cost to manage recyclables in the southern sector.

C.1.3 Marginal Cost of Managing Yard Waste

General Disposal is paid a per-ton fee for the collection of yard waste in the northern sector.[84] This fee in FY 1992 was $62.39.[85] The yard waste collected by General Disposal was delivered to the Utility's South Transfer Station and hauled to Cedar Grove for processing into compost. For small changes in tonnage, it is assumed that there is no Marginal Cost of operating the transfer stations or hauling the yard waste to Cedar Grove. The Utility pays U.S. Disposal for the processing of this yard waste at Cedar Grove.[86] In FY 1992 the processing rate was $12.50 per ton.[87] The Marginal Cost for the northern sector of collecting and processing yard waste is $74.89 per ton (i.e., $62.39 plus $12.50). U.S. Disposal is paid a per-ton fee for the collection and processing of yard waste in the southern sector.[88] This fee in FY 1992 was $93.31.[89] Because this per-ton fee is inclusive of collection, transfer, and processing, it is the Marginal Cost for these services in the southern sector.

C.1.4 Summary of Marginal Cost Results

Table C.4 summarizes the components of the Marginal Cost calculations.

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[83] In December of 1992 the per ton fee paid Recycle Seattle was $56.08 per ton, while the average market adjustment in FY 92 was $10.92 per ton. (Monthly invoices for services provided by Recycle Seattle, January 1, 1992 through December 31, 1992.)

[84] "Solid Waste and Yard Waste Collection Contract," City of Seattle and General Disposal Corp., January 1, 1989 - March 31, 1996, page 29.

[85] Monthly invoices for yard waste collection services, January 1, 1992 through December 31, 1992.

[86] "Solid Waste and Yard Waste Collection Contract," City of Seattle and U.S. Disposal, January 1, 1989 - March 31, 1996, page 24.

[87] Monthly invoices for yard waste collection and processing, January 1, 1992 through December 31, 1992.

[88] "Solid Waste and Yard Waste Collection Contract," City of Seattle and U.S. Disposal, January 1, 1989 - March 31, 1996, page 24.

[89] Monthly invoices for yard waste collection and processing, January 1, 1992 through December 31, 1992.

C.2 Program Incremental Costs

C.2.1 Case 2: No Curbside Recycling Program

Table C.5 shows the differences in tons and costs with and without the curbside recycling program. All tonnages and costs excluded from this table remain constant for Cases 1 through 4, i.e., they do not affect the Program Incremental Cost estimates. In this table the Garbage Collection and Processing; Recyclables Collection, Processing, and Marketing; Yard Waste Collection and Processing; and the Rail Haul and Disposal costs reflect payments to contractors pursuant the various Utility contractual relationships. The Utility costs or savings reflect non-contractual Program Incremental Costs or Savings incurred by the Utility as shown in Table C.6.

The Program Incremental Cost analysis assumes that the current Structure Prices (i.e., fixed prices) and Tonnage Prices (i.e., variable prices) for collection of garbage without a curbside recycling and/or yard waste composting program would be the same as the actual FY 1992 garbage collection prices. To test the reasonableness of this assumption, CSI conducted an engineering assessment of garbage collection costs and determined that the per-ton Tonnage Price that would have been paid to the contractor would more than cover the contractor's incremental cost, including a profit margin. Therefore, it is reasonable to assume that the garbage collection market prices, and in particular the Structure Price and per-ton Tonnage Price without these programs would be no greater than those market prices charged in FY 1992 with the curbside recycling and yard waste composting programs in place.

Without the curbside recycling program, the tons of garbage collected by General Disposal increased by an assumed 26,961 tons (i.e., 25,475 from the residential curbside collection program and 1,486 from the apartment recycling program). The Program Incremental Cost for each additional ton of garbage collected by General Disposal in $29.34,[90] resulting in an increased cost of collecting garbage of $791,000. Similarly, the increased cost of collecting an additional 24,299 tons (i.e., 22,812 from the residential curbside collection program and 1,487 from the apartment recycling program) by U.S. Disposal at the $33.95/ton[91] average Tonnage Price is about $825,000.

Because it is assumed that the curbside recycling program was never instituted, there would be no costs associated with Recycling Collection, Processing, and Marketing. The incremental savings, therefore, are the payments made to Recycle America and Recycle Seattle. The incremental saving of $234,605 for the apartment recycling program was derived from the detailed expenditures as shown in Table B.4 or Appendix B.

There is no incremental cost for the Yard Waste Collection, Processing, and Marketing program because it would be the same with or without the curbside recycling program.

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[90] The $29.34/ton unit cost is equal to the FY 92 Tonnage Price of $2,836,124 divided by 96,679 tons collected in FY 92.

[91] The $33.95/ton unit cost is equal to the FY 92 Tonnage Price of $1,543,942 divided by 45,475 tons collected in FY 92.

Because it was assumed that recyclables that were self-hauled, will still be diverted from the waste stream, there is no tonnage difference in self-hauled tonnage. Without the curbside recycling program, the total quantity of garbage delivered to the railhead for disposal is 485,028 tons. Based on the rate schedule provided in Table C.3, the unit cost for garbage hauled to the Columbia Ridge Landfill for disposal is $42.31. Adding to this the Oregon tax of $0.50 per ton results in a total per-ton cost of $42.81. With the curbside program, the per-ton cost in FY 1992 was $43.72. The Program Incremental Cost of rail-haul and disposal is equal to 485,028 times $42.81, minus 433,768 times $43.72, or about $1.80 million.

Table C.6 shows an estimated incremental savings of non-contractual costs incurred by the Utility if there were no curbside recycling program. Most of these costs or savings are expenditures attributed to the curbside recycling program, as provided in Tables B.2 through B.14 of Appendix B. The derivations of these non-contractual incremental costs are discussed below.

The assumed incremental G&A expenses can have a significant impact on the estimated Program Incremental Costs. For this analysis it was assumed that $148,500, or the equivalent of about four additional full-time employees, were required for customer service, procurement, planning, and other G&A activities related to the curbside recycling program.

The $31,078 incremental savings for Collection/Processing shown in Table C.5 is the "Contract Administration" costs in Table B.4. The $172,162 Promotion & Education incremental savings is taken directly from Table B.8. For the curbside recycling program, about $183,300 of the Miscellaneous Recycling and Planning costs was assumed to be incremental costs. This amount is the sum of the total "Recruiting," "Apartment Recycling," and "Market Development" costs shown in Table B.9 of Appendix B. These expenses were used as a proxy, since a portion of the Miscellaneous Recycling and Planning expenses may not have been incurred if there were no commitment to a curbside recycling program.

The 51,260 tons of recyclables collected (i.e., 25,475 by Recycle America, 22,812 by Recycle Seattle, and 2,973 from the apartment recycling program) bypassed the Utility's transfer stations. If the recyclables were collected as garbage, the Utility would incur an additional cost to transfer and haul this material. The garbage operation cost at the transfer stations in FY 1992 was $583,254 (see Table B.5). Dividing this by the 142,154 tons of garbage transferred in FY 1992 results in an average transfer cost of about $4.10 per ton. Multiplying this average operation cost by 51,260 tons of additional garbage results in an estimated incremental transfer cost for the recyclables of $210,318. This additional tonnage must also be transported to the rail head. The cost of transporting the 142,154 tons of garbage in FY 1992 was $356,098, or about $2.51 per ton. Multiplying this average haul cost by 51,260 tons of additional garbage results in an estimated incremental haul cost of $128,407. The total incremental transfer and haul cost is estimated to be $338,725 (i.e., $210,318 plus $128,407).[92]

Capital Costs incurred by the Utility include capital outlays for the transfer stations and transfer vehicles. It is assumed that the capacity at the transfer stations, including the compacting system,

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[92] This analysis assumes that the total operating and haul costs at the transfer stations will increase in direct proportion to the increase in tonnage. This assumption may result in an overestimate of the incremental cost.

can accommodate the additional 51,260 tons of garbage. Based on a five-day-a-week, 52-week-a-year operation, this represents an average increase of approximately 100 TPD at the North Transfer Station and 95 TPD at the South Transfer Station. Based on the contractual requirement that each container must have a minimum of 25 tons, a maximum of four additional trips per day must be made from each transfer station to the Union Pacific railhead. To accommodate this additional tonnage, it is assumed that one additional tractor and chassis would be required for use at the North Transfer Station. Because of the close proximity of the South Transfer Station and the railhead, it is assumed that the additional tonnage can be transferred using the same equipment as is currently being used. It is further assumed that the purchase price of the tractor and chassis is $75,000 and that they have an expected useful life of seven years. Using a cost of capital of 7 percent, the resulting annual incremental cost is about $13,900.[93]

C.2.2 Case 3: No Yard Waste Program

Table C.5 shows the differences in tons and costs with and without the curbside yard waste program. All tonnages and costs excluded from this table are not affected by the program and do not affect the Program Incremental Cost estimate. In this table the Garbage Collection and Processing; Recyclables Collection, Processing, and Marketing; Yard Waste Collection and Processing; and the Rail-Haul and Disposal costs reflect payments to contractors pursuant the various Utility contractual relationships. The Utility costs or savings reflects non-contractual Incremental Costs or Savings incurred by the Utility as shown in Table C.6.

Without the curbside yard waste program, the tons of garbage collected by General Disposal increased by an assumed 24,547 tons, i.e., the tonnage of yard waste collected by General Disposal in FY 1992. The Incremental Cost for each additional ton of garbage collected by General Disposal is $29.34, resulting in an increased cost of collecting garbage of $720,000. Similarly, the increased cost of collecting an additional 10,243 tons by U.S. Disposal at the $33.95/ton average Tonnage Price is about $348,000.

The Incremental Savings for Yard Waste Collection, Processing, and Marketing Cost are the payments made to General Disposal, U.S. Disposal, and Cedar Grove in FY 1992. The 11,129 tons of self-hauled yard waste is assumed to still be delivered to the transfer stations, transferred to the Union Pacific railhead, and eventually disposed of in the Columbia Ridge Landfill. Without the curbside yard waste program, the total quantity of garbage delivered to the railhead for disposal is 479,687. The incremental cost of rail-haul and disposal is equal to 479,687 times $42.81, minus 433,768 times $43.72, or about $1.57 million.

Table C.6 shows an estimated Incremental Savings of non-contractual cost incurred by the Utility if there were no curbside yard waste program. Most of these costs or savings are expenditures attributed to the curbside yard waste program, as provided in Tables B.2 through B.14 of Appendix B. The derivations of these non-contractual incremental costs are discussed below.

For this analysis, it was assumed that $33,750, or the equivalent of one additional full-time employee, was required for customer service, procurement, planning, and other G&A activities related to the yard waste program. This is about six percent of the $589,000 G&A expense

[93] See Appendix D for methodology used to estimate Capital Costs.

allocated to the yard waste program.

The $88,780 incremental savings for Collection/Processing shown in Table C.6 is the "Contract Administration" cost shown in Table B.4. The $65,438 Promotion and Education Incremental Costs is taken directly from Table B.8.

For the yard waste program, about $64,000 of the Miscellaneous Recycling and Planning costs were assumed to be incremental costs. This amount is the sum of the total "Yard Waste Process," "Overall Yard Waste," "Compost Quality," and "Co-Composting" costs shown in Table B.9 of Appendix B. Again, these expenses were used as a proxy, since a portion of all the Miscellaneous Recycling and Planning expenses may not have been incurred if there were no commitment to the yard waste program.

The 10,243 tons of yard waste collected by U.S. Disposal in FY 1992 bypassed the Utility's transfer stations. If collected as garbage, the Utility would incur an additional cost to transfer and haul this material. The garbage operation cost at the transfer stations in FY 1992 was $583,254 (see Table B.5). Dividing this by the 142,154 tons of garbage transferred in FY 1992 results in an average transfer cost of about $4.10 per ton. Multiplying this average operation cost by 10,243 tons of additional garbage results in an estimated incremental transfer cost for recyclables of $42,027. Since the other 35,676 tons of yard waste (i.e., 24,547 collected by General Disposal and 11,129 tons that were self-hauled) were delivered to the transfer stations in FY 1992, it is assumed that there is no incremental cost or saving for transferring this tonnage.

Without the curbside yard waste program, all of the 45,919 tons of yard waste would be hauled to the railhead rather than 35,676 of this yard waste being hauled to the Cedar Grove Composting Facility. (The balance of 10,243 tons was hauled to Cedar Grove by U.S. Disposal as part of its collection contract.) Because the haul distance to the railhead is less than the haul distance to Cedar Grove, there would be an incremental saving in haul costs. The cost of transporting the 142,154 tons of garbage in FY 1992 was $356,098 (see Table B.6), or about $2.51 per ton. Multiplying this average haul cost by 45,919 tons of additional garbage results in an estimated haul cost of $115,028. The incremental haul saving for this additional 45,919 tons is to be the FY 1992 haul cost for yard waste of $179,220 (see Table B.6) minus the estimated haul cost to the railhead of $115,028, or $64,192.[94]

The total incremental transfer and haul savings is estimated to be $64,438 minus $42,027, or $22,165.

Capital Costs incurred by the Utility include capital outlays for the transfer stations and transfer vehicles. It is assumed that the capacity at the transfer stations, including the compacting system can accommodate the additional 10,243 tons of yard waste that was collected by U.S. Disposal and diverted from the transfer stations. The remaining 35,676 tons of yard waste were delivered to the transfer stations in FY 1992. For this analysis, it is assumed that the increase in capital costs required to transfer 45,919 tons of yard waste about five miles to the railhead is equal to

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[94] This analysis assumes that the total operating and haul costs at the transfer stations will increase in direct proportion to the increase in tonnage. This assumption may result in an overestimate of the incremental cost.

the capital costs saved by avoiding the transfer of 35,676 tons 20 miles to Cedar Grove. That is, it is assumed that there is no incremental capital cost.

C.2.3 Case 4: No Curbside Recycling and Yard Waste Programs

Table C.5 shows the differences in tons and costs with and without both the curbside recycling and yard waste programs. All tonnages and costs excluded from this table are not affected by the program and do not affect the Program Incremental Cost estimate. In this table the Garbage Collection and Processing; Recyclables Collection, Processing, and Marketing; Yard Waste Collection and Processing; and the Rail-Haul and Disposal costs reflect payments to contractors pursuant the various Utility contractual relationships. The Utility costs or savings reflects non-contractual Incremental Costs or Savings incurred by the Utility as shown in Table C.6.

Without the recycling and curbside yard waste programs, the tons of garbage collected by General Disposal increased by an assumed 51,508 tons. The incremental cost for each additional ton of garbage collected by General Disposal is $29.34, resulting in an increased cost of collecting garbage of $1.51 million. Similarly, the increased cost of collecting an additional 34,542 tons by U.S. Disposal at the $33.95/ton average Tonnage Price is about $1.17 million.

Because it is assumed that the curbside recycling program was never instituted, there would be no costs associated with Recycling Collection, Processing, and Marketing. The Incremental Savings, therefore, are the payments made to Recycle America and Recycle Seattle. Similarly, the Incremental Savings for the apartment recycling program are the payments that were made in FY 1992 for the apartment program. The Incremental Savings for Yard Waste Collection, Processing, and Marketing Cost are the payments made to General Disposal, U.S. Disposal, and Cedar Grove in FY 1992.

The 11,129 tons of self-hauled yard waste are assumed to still be delivered to the transfer stations, transferred to the Union Pacific railhead, and eventually disposed of at the Columbia Ridge Landfill. Without the curbside recycling and yard waste programs, the total quantity of garbage delivered to the railhead for disposal is 530,947. The Incremental Cost of rail-haul and disposal is equal to 530,947 times $42.52, minus 433,768 times $43.72, or about $3.61 million.

Table C.6 shows an estimated incremental savings of non-contractual cost incurred by the Utility if there were no curbside yard waste program. Most of these costs or savings are expenditures attributed to the curbside yard waste program, as provided in Tables B.2 through B.14 of Appendix B. Except for the G&A and Miscellaneous Recycling expenses, the Incremental Savings for non-contractual costs is equal to the sum of the incremental savings for the curbside recycling and yard waste programs.

The incremental G&A expenses for both programs was assumed to be $249,750, or the equivalent of about six additional full-time G&A employees. The incremental G&A expense for both programs is assumed to be greater than the sum of each program's incremental G&A expenses because additional planning and administrative staff members, e.g., a director of recycling, are assumed to be required for a more complex organization and program. Because the curbside recycling and yard waste programs are the main focus of the waste diversion efforts, it is also likely that without these two programs many of the other recycling activities (e.g., commercial recycling and backyard composting) would be limited or eliminated. The estimate

of Program Incremental Costs in this study, however, is limited to the analysis of only those costs related to the curbside recycling and yard waste programs, i.e., any incremental costs or savings of ancillary programs are not included in the analysis.

For both the curbside recycling and yard waste programs, about $386,000 Miscellaneous Recycling and Planning costs were assumed to be incremental costs. This amount is the sum of incremental Miscellaneous Recycling and Planning costs attributed to each program plus the cost of the "Waste Stream Projection" and "Waste Stream Composition" studies. If there were no curbside recycling and yard waste programs, then it was assumed that the waste studies would most likely not have been performed.

TABLE C.1: GENERAL DISPOSAL GARBAGE PAYMENTS (FY92)

ITEM	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	NOVEMBER	OCTOBER	DECEMBER	TOTAL
Charges for the Month													
Garbage Collection													
Structure Base	235,302	235,302	235,302	235,302	235,302	235,302	235,302	235,302	235,302	235,302	235,302	235,302	2,823,620
Tonnage Price	236,344	236,344	236,344	236,344	236,344	236,344	236,344	236,344	236,344	236,344	236,344	236,344	2,836,124
Total	471,645	471,645	471,645	471,645	471,645	471,645	471,645	471,645	471,645	471,645	471,645	471,645	5,659,745
Paid Specials (Sec. 500)	2,075	1,829	1,278	1,978	3,749	2,082	1,959	1,729	2,409	1,323	1,384	1,864	23,659
SWU Adjustment	0	0	0	0	0	0	0	0	0	(68)	0	(50)	(118)
Affix Hazardous Stickers (Sec 215)	0	0	0	0	0	0	0	0	0	0	0	1,864	1,864
Install and Maintenace of FAX (Sec192(a))	4,010	5,920	4,381	1,826	2,870	768	2,801	4,178	2,257	916	1,676	2,670	34,274
Collection Day Change Notice	0	0	0	0	0	0	0	0	0	0	0	0	0
Vehicle and Driver Payment	0	0	0	0	0	0	0	0	0	0	0	0	0
Bulky Items (Sec 185)	21	90	55	83	42	62	76	62	42	28	35	28	624
White Goods (Sec 185)	166	155	89	166	33	365	299	310	221	221	266	321	2,613
Lid-Locker Containers (Sec 272)													0
Installation	175	304	65	278	84	284	130	91	317	130	355	426	2,639
Collections	1,190	1,245	1,245	1,260	1,268	1,282	1,299	1,308	1,324	1,352	1,376	1,423	15,570
Trash Tag Sale	1,190	448	656	517	586	863	794	621	1,035	586	379	983	8,658
Cart Exchange/Net Compay Billing (Sec 255)	10,222	17,032	13,712	16,052	12,334	13,081	14,475	10,956	19,322	23,257	50,265	40,338	241,045
SWU Adjustment	(129)	(116)	(83)	(349)	0	(133)	(382)	0	(465)	(498)	0	(581)	(2,736)
Cart Replacement/Net Company Billing (Sec 2	1,664	1,539	1,775	1,956	1,157	1,613	2,440	1,949	4,665	3,557	11,072	8,657	42,045
SWU Adjustment	(89)	(145)	(11)	(30)	(30)	(19)	0	0	0	(1,813)	0	(2,799)	(4,937)
Liquidated Damages (Sec 960)	0	0	(15)	(30)	0	0	0	0	0	0	0	0	(45)
Missed Collection	0	0	0	0	0	0	0	0	0	0	0	0	0
Non-Collection (Sec 630)	0	0	0	0	0	0	0	0	0	0	0	0	0
Interest for Late Payment	0	0	0	0	0	0	0	0	0	0	0	0	0
Correction/Wheeled Containers	0	0	0	0	0	0	0	0	0	0	0	0	0
Paid Spec./Multi-Family Exempt	711	730	731	731	731	731	731	731	731	731	731	731	8,752
Truck Delay at Transfer Station	0	0	0	0	0	0	0	0	0	0	0	0	0
CPI Ajustment	0	710	0	0	0	0	0	0	0	0	0	0	
Interest for Adjustments	0	142	0	0	0	0	0	0	0	0	196	0	338
Reconcile with Audited Financials													(1,820)
Monthly Total	492,852	501,528	495,523	496,084	494,469	492,626	496,267	493,580	503,504	501,366	539,379	527,520	6,032,169

Source: Invoices for Garbage Collection Services from January 1 through December 31, 1992.

TABLE C.2: U.S. DISPOSAL GARBAGE PAYMENTS (FY92)

ITEM	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	NOVEMBER	OCTOBER	DECEMBER	TOTAL
Charges for the Month													
Garbage Collection													
Structure Base	128,785	128,785	128,785	128,785	128,785	128,785	128,785	128,785	128,785	128,785	128,785	128,785	1,545,425
Tonnage Price	128,662	128,662	128,662	128,662	128,662	128,662	128,662	128,662	128,662	128,662	128,662	128,662	1,543,942
Total	257,447	257,447	257,447	257,447	257,447	257,447	257,447	257,447	257,447	257,447	257,447	257,447	3,089,367
Paid Specials (Sec. 500)	2,108	838	994	2,249	881	917	1,058	(1,869)	554	205	268		8,202
SWU Adjustment	0	0	0	0	0	0	0	0	(17)	0	0	311	295
Yard Waste Publicity (Sec 340)	0	0	0	0	0	0	0	0	0	0	0	0	0
Affix Hazardous Stickers	0	0	0	0	0	0	0	0	0	0	0	0	0
Promotion & Education	0	0	0	0	0	0	0	0	0	0	0	0	0
Cart Exchanges	0	0	0	0	0	0	0	0	0	0	119,188	6,408	125,596
Correct for Cart Exchanges	0	0	0	0	0	0	0	0	0	0	0	0	0
Trash Tag Sale	535	202	294	233	264	387	356	279	465	264	171	442	3,892
Replacement Carts Payment: (Sec 210)													0
Mini Cans	367	338	639	583	216	338	385	254	451	1,156	620	498	5,847
32 Gallon Cans	1,771	224	1,513	2,082	944	1,552	1,293	2,948	3,207	6,310	2,625	1,991	26,459
60 Gallon Cans	55	165	385	110	220	165	110	110	165	385	330	165	2,365
90 Gallon Cans	0	0	0	0	0	0	0	0	55	55	0	55	165
Missed Collects Rebate	0	0	0	0	0	0	0	0	0	0	0	0	0
Hazardous Waste Sticker Payment	0	0	0	0	0	0	0	0	0	0	0	0	0
Liquidated Damages	0	0	0	0	0	0	0	0	0	0	0	0	0
Bulky & White Goods (Sec 185)	199	244	554	221	89	266	221	155	44	89	244	266	2,590
Lidlockable Containers Install (Sec 272)	0	0	0	0	0	0	0	0	0	0	0	0	0
Savings of Structures on Back Yard Service	(5,237)	(5,237)	(5,237)	(5,237)	(5,237)	(5,237)	(5,237)	(5,237)	(5,237)	(5,237)	(5,237)	(5,237)	(62,839)
Additional Payment for Half-Can Service (127	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	1,179	14,153
Reloading Contaminants	0	0	0	0	0	0	0	0	0	0	0	0	0
Special Collection (Sec 500B)	2,192	0	236	0	0	0	0	0	0	0	0	0	2,428
Replacement of Recycling Carts	240	600	60	420	420	300	720	780	840	360	2,100	840	7,680
CPI Adjustment	0	169	0	0	0	0	0	0	0	0	0	0	169
Interest for Adjustments	0	67	0	0	0	0	0	0	0	0	36	0	103
Reconcile with Audited Financials													59,086
Monthly Total	260,857	256,236	258,065	259,288	256,424	257,315	257,534	256,047	259,154	262,214	378,972	264,366	3,285,558

NOTE: Does not include Yard Waste Publicity and Promotion & Education Fees.
Source: Invoices for Garbage Collection Services from January 1 through December 31, 1992.

TABLE C.3: RAIL HAUL AND LANDFILL RATES

BASE AMOUNT PER TON	1989 Base Prices		1992 Base Prices	
	Columbia Ridge	East Washington	Columbia Ridge	East Washington
Less than 450,000 tons per yeai	36.67	34.40	43.22	40.54
450,000 tons per year or more	35.90	31.38	42.31	36.99
525,000 tons per year or more	35.65	31.19	42.02	36.76
600,000 tons per year or more	35.40	30.99	41.72	36.53
800,000 tons per year or more	35.15	30.79	41.43	36.29
1,000,000 tons per year or more	34.90	30.59	41.13	36.05

NOTE: 1992 Rates based on monthly invoices and include average incidental charges and payments.

SOURCE: "Contract Between the City of Seattle and Washington Waste Systems, Inc.for the Transportation and Disposal of Waste."

TABLE C.4: COMPONENTS OF MARGINAL COST CALCUALTIONS

MANAGED MSW	NORTH SECTOR ($/ton)	SOUTH SECTOR ($/ton)
GARBAGE		
Collection	29.34	33.95
Transfer	-	-
Disposal	43.22	43.22
Total	73.06	77.67
RECYCLABLES		
Collection & Processing	56.95	67.52
YARD WASTE		
Collection	62.39	93.31
Transfer	-	inc.
Processing	12.50	inc.
Total	74.89	93.31

TABLE C.5: INCREMENTAL COSTS (SAVINGS) AND TONNAGE FOR ALTERNATIVE CASES

EXPENSE ITEM	CASE 1 CURRENT PROGRAM		CASE 2 NO CURBSIDE RECYCLING PROGRAM			CASE 3 NO YARD WASTE PROGRAM			CASE 4 NO RECYCLING & YARD WASTE PROGRAMS		
	MSW (tons)	COST ($)	MSW (tons)	COST ($)	INCR. COST ($)	MSW (tons)	COST ($)	INCR. COST ($)	MSW (tons)	COST ($)	INCR. COST ($)
GARBAGE											
General Disposal	96,679	6,032,166	123,640	6,823,080	790,914	121,226	6,752,264	720,098	148,187	7,543,177	1,511,011
U.S. Disposal	45,475	3,295,558	69,774	4,120,544	824,986	55,718	3,643,323	347,765	80,017	4,468,309	1,172,751
Self Haul to Transfer Stations	97,276		97,276			108,405			108,405		
Self Haul to Railhead	194,338		194,338			194,338			194,338		
RECYCLABLES COLLECTION, PROCESSING, & MARKETING											
Recycle America	25,475	1,456,661	0		(1,456,661)	25,475	1,456,661	0	0		(1,456,661)
Recycle Seattle	22,812	1,524,754	0		(1,524,754)	22,812	1,524,754	0	0		(1,524,754)
Apartment Recycling	2,973	234,605	0		(234,605)	2,973	234,605	0	0		(234,605)
YARD WASTE COLLECTION, PROCESSING, & MARKETING											
General Disposal	24,547	1,531,487	24,547	1,531,487	0	0		(1,531,487)	0		(1,531,487)
U.S. Disposal	10,243	955,774	10,243	955,774	0	0		(955,774)	0		(955,774)
Self Haul to Transfer Stations	11,129		11,129			0			0		
Processing (North & Self Only)1	35,676	445,950	35,676	445,950	0	0		(445,950)	0		(445,950)
RAIL HAUL & DISPOSAL	433,768	18,964,337	485,028	20,764,049	1,799,712	479,687	20,535,400	1,571,063	530,947	22,575,866	3,611,529
SOLID WASTE UTILITY					(182,400)			(274,200)			(662,900)
TOTALS	530,947	34,441,292	530,947	34,640,884	17,192	530,947	34,147,007	(568,485)	530,947	34,587,352	(516,840)

1 The subtotal of yard waste brought to the North Transfer Station is added here only as a reference. The subtotal includes the General Disposal and Self Haul waste above.

TABLE C.6: SWU'S NON-CONTRACTUAL PROGRAM INCREMENTAL SAVINGS (COSTS)

FUNCTION	RECYCLABLES	YARD WASTE	BOTH PROGRAMS
General & Administrative	$148,500	$33,750	$249,750
Taxes	0	0	0
Collection/Processing	31,078	88,780	119,858
Transfer & Haul	(338,725)	22,165	(316,560)
Promotion & Education	172,162	65,438	237,600
Misc. Recycling Expenses	183,293	64,023	386,119
Capital Costs	(13,900)	0	(13,900)
Total	$182,400	$274,200	$662,900

Appendix D
Capital Cost Calculation

A capital expense is the purchase of an asset or service with a useful life of greater than one year. Accountants report capital expenses as either capital outlays, i.e., the actual payment made during the year, or depreciated/amortized expenses, e.g., using straight-line depreciation the capital outlay is divided by the useful life of the asset.

Capital assets may be purchased entirely with cash, financed over time using borrowed funds, or utilize a combination of the two. If totally or partially financed, interest payments on borrowed funds are reported by accountants as interest expenses.

Following these accounting practices, the cost of a capital asset in a given reporting period (e.g., fiscal year) is reported as either the capital outlay incurred, or the depreciation/amortization expense incurred in the reporting period, plus interest paid, if any, on borrowed funds to finance the capital asset. Some financial reports, such as a cash flow analysis, also report the actual debt service, i.e., principal plus interest payments, on borrowed funds.

Although these approaches are appropriate for generating financial statements of non-profit organizations, none is an appropriate measure of the economic capital costs of the asset. The reporting of capital outlays does not recognize that a capital asset will be used over two or more years and that, therefore, its costs should be spread over the asset's useful life. The depreciation/amortization approach does not adequately distinguish between the same asset purchased with cash or with borrowed funds. Because loan repayment and debt service payments, and in particular the interest portion of such payments, can vary significantly from year to year based solely on the means of borrowing funds and not the use of the asset, these expenses are not an appropriate measure of the capital cost of the asset.

The approach used in the report to calculate capital costs is to "annualize" or "capitalize" capital outlays over the useful life of the asset using a cost of capital of 7 percent.[95] Generally, the cost of capital reflects the rate of return expected on invested funds.

Using this approach the capital cost of an asset is independent of the method used to pay for the asset, and has the same annual value over the useful life of the asset.

To illustrate the method used to calculate capital costs and compare it to the other ways of reporting capital expenses, consider a transfer tractor and trailer with a 5 year useful life and a purchase price of $105,000.

To estimate the annual capital cost the purchase price, i.e., capital outlay, of $105,000 is multiplied by the following capitalization factor:

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[95]The cost of capital is related to the rates of return that can be earned on invested funds and the rates of interest that must be paid on borrowed funds. As the economy changes and interest rates increase or decrease, the cost of capital may also change over time. The 7-percent cost of capital is about the mid-point of cost of capital often used for public entities.

$$\frac{r}{1-[1/(1+r)^n]}$$

where "r" is the cost of capital, or .07 in this analysis, and "n" is the useful life of the asset.

Substituting .07 for "r" and 5 or "n" in the above equation results in a capitalization factor of:

$$0.2539=\frac{.07}{1-[1/(1.07)^5]}.$$

Multiplying $105,000 by this capitalization factor results in an annual capital cost of $25,610. Capitalization factors for various costs of capital and useful lives of assets are provided in Table D.1.

Table D.2 shows the difference between the capital cost calculated above for this tractor/trailer over its five-year useful life and the capital expenses reported using various accounting procedures. This table clearly shows that the differences among these reporting procedures are significant. Also note that the capital cost as calculated above is identical to the loan repayment or debt service schedule on a seven-percent loan with a constant annual repayment schedule, as shown in Case 7 in Table D.2.

TABLE D.1: CAPITALIZATION FACTORS

NUMBER YEARS	COST OF CAPITAL					
	5%	6%	7%	8%	9%	10%
2	**0.5378**	**0.5454**	**0.5531**	**0.5608**	**0.5685**	**0.5762**
3	0.3672	0.3741	0.3811	0.3880	0.3951	0.4021
4	**0.2820**	**0.2886**	**0.2952**	**0.3019**	**0.3087**	**0.3155**
5	0.2310	0.2374	0.2439	0.2505	0.2571	0.2638
10	**0.1295**	**0.1359**	**0.1424**	**0.1490**	**0.1558**	**0.1627**
15	0.0963	0.1030	0.1098	0.1168	0.1241	0.1315
20	**0.0802**	**0.0872**	**0.0944**	**0.1019**	**0.1095**	**0.1175**
30	0.0651	0.0726	0.0806	0.0888	0.0973	0.1061
40	**0.0583**	**0.0665**	**0.0750**	**0.0839**	**0.0930**	**0.1023**
50	0.0548	0.0634	0.0725	0.0817	0.0912	0.1009

TABLE D.2: COMPARISON OF CAPITAL COSTS AND OTHER ACCOUNTING METHODS - PURCHASE OF TRACTOR/TRAILER WITH 5-YEAR USEFUL LIFE FOR $105,000

YEAR	CAPITAL COST	CASE 1	CASE 2	CASE 3	CASE 4	CASE 5	CASE 6	CASE 7	CASE 8
1	25,609	105,000	112,350	112,350	21,000	28,350	28,350	25,609	28,350
2	25,609	0	6,072	5,880	21,000	27,072	26,880	25,609	26,880
3	25,609	0	4,704	4,410	21,000	25,704	25,410	25,609	25,410
4	25,609	0	3,241	2,940	21,000	24,241	23,940	25,609	23,940
5	25,609	0	1,675	1,470	21,000	22,675	22,470	25,609	22,470

DEFINITION OF CASES:

CASE 1: Capital Outlay reporting. Purchased with cash.

CASE 2: Capital Outlay reporting. Financed with borrowed funds. Interest 7%. Constant annual payments

CASE 3: Capital Outlay reporting. Financed with borrowed funds. Interest rate of 7%. Constant principal payment, interest paid on unpaid balance.

CASE 4: Straight line depreciation/amortization reporting. Purchased with cash.

CASE 5: Straight line depreciation/amortization reporting. Financed with borrowed funds. Interest rate of 7%. Constant annual payments.

CASE 6: Straight line depreciation/amortization reporting. Financed with borrowed funds. Interest rate of 7%. Constant principal payment

CASE 7: Debt Service reporting. Financed with borrowed funds. Interest rate of 7%. Constant annual payments

CASE 8: Debt Service reporting. Financed with borrowed funds. Interest rate of 7%. Constant annual principal payments.

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