RECYCLING AND DISPOSAL OF INDUSTRIAL, COMMERCIAL, AND INSTITUTIONAL SOLID WASTE AND POLYSTYRENE FOAM: RESULTS OF A SURVEY

By

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ABSTRACT

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Commercial, industrial, and institutional facilities in southeast Michigan were surveyed regarding solid waste and polystyrene (PS) foam disposal volume, recycling volume, and their attitudes and perceptions about current solid waste issues. 194 firms of various sizes from 16 industry groups responded. Companies reported that they feel recycling is important. Problems with recycling were linked to education, transportation, and costs. Respondents opposed incineration. Currently, respondents say little environmental pressure is felt from employees, consumers, or outside environmental groups. Respondents expect future PS foam demand to increase, but some have considered, or switched to, alternative materials to PS foam. No sizeable problems that may affect PS recycling, such as food contamination, were reported.

Companies report the largest volume of their waste stream is paper/wood, followed by plastics, "others" (comprised of food, yard, and all other waste), and metals. The largest volume currently recycled is paper/wood, followed by "others", plastics, and metals. By the year 2000, recycling is expected to almost triple. Plastics recycling is expected to have the largest individual increase, but the expected increase in paper/wood products will have the largest impact on waste stream reduction. Overall, these recycling efforts could reduce current waste stream volume by 41%.

Dedicated to

My loving parents, Harrison and Ethel Arrowood

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1.0 INTRODUCTION

Decreasing landfill space, groundwater contamination, public relations, and escalating solid waste disposal costs are just a few of the environmental problems that we face as the 21st century approaches. With half of current US landfills to be closed by 1995, careful waste management is a necessity. Environmental disasters caused by corporations and nature have added public relations and political twists to solid waste issues. Reduce, re-use and recycle have become integral parts of our solid waste solutions. Americans are struggling to figure out which mix of waste management methods is best. Recycling programs for consumers and industries are growing. Waste reduction programs are also widespread. Alternatives such as incineration and waste to energy are controversial. Transportation costs related to solid waste disposal options are critical. Even when methods are deemed economically feasible, consumers and industry professionals may not be willing to participate.

Although many companies have adopted environmental awareness programs, there is sometimes very little information available to use for program implementation. We are approaching an age when solid waste management is no longer just a "socially right" thing to do. Because of physical changes in the environment, companies will be forced to make critical solid waste management

choices. This research will examine some of these choices and give a perception from waste professionals in companies about what is important to them in the future.

Polystyrene foam, commonly referred by the Dow Chemical trade name "styrofoam", for their insulation, and sometimes referred to as EPS (expanded polystyrene), has become a material facing many environmental issues. Although PS foam can be easily recycled, McDonald's recent substitution of PS foam with a paper based product has manufacturers and users questioning its environmental "friendliness". In addition, legislation has banned or limited the use of chlorofluorocarbons (CFC) in foams and other products such as cooling agents. Legislation will soon prohibit CFCs all together. Companies and academia have been studying the recyclability of PS foam and comparing it to other plastic and paper based products. Groups such as the National Polystyrene Recycling Company (NPRC), formed by the world's seven largest polystyrene manufacturers, have been emerging to help educate the public and guide the recycling efforts for PS foam. Dart Container located in Mason, MI currently picks up PS foam free of charge from transfer stations and high users of the product. The material is returned to their facility and recycled, currently at breakeven cost. The following literature will present many other examples of industrial and consumer concern for solid waste, including PS foam.

In 1991, Michigan State University was funded by the State of Michigan's Department of Natural Resources to develop a business plan and complete research for the feasibility of a polystyrene recycling facility for southeast Michigan. As part of the research, a survey was developed and sent to 2000 randomly selected

companies; 194 responded. The survey was a component of the business plan and asked questions about solid waste and PS foam disposal and recycling. The topics covered included perceptions about various current issues as well as waste stream breakdowns. This research explores and statistically analyzes waste stream breakdowns, environmental attitudes, and perceptions obtained from the survey.

2.0 LITERATURE REVIEW

The following sections outline issues related to industrial and post consumer solid waste and more specifically, PS foam. The first section will discuss solid waste measurement methods and waste stream sizes. This will be followed by a discussion of solid waste disposal methods and issues, incineration, recycling, evolution of recycling programs, and separation of solid waste. Various PS foam related issues presented include waste management issues, PS foam recycling and waste stream contribution, virgin and recycled uses, PS foam alternatives, future demand, seasonality, associated disposal and processing costs, and curbside collection. The literature review ends with a section related to solid waste environmental attitudes, perceptions, and participation issues.

Solid Waste Measurement Methods and Waste Stream Size

Waste generation rates are available for some residential, commercial and industrial waste streams. Sometimes residential and commercial may be combined. Institutional generation rates are usually included in commercial estimates. Construction and demolition, and industrial special waste generation rates have also been estimated. Residential, i.e. single family and multi-unit housing, waste generation estimates are usually more accurate than commercial, industrial, and

institutional estimates because they have minimal variance with more measurable populations. Residential rates are usually measured on the basis of pounds/capita/day (PCD), though pounds/household/day may be calculated. Rates are based on 365 days/year (Resource Recycling Systems Inc., 1990).

Commercial, industrial and institutional waste measurement requires analysis of the activity level for many different market areas. The most frequent activity measure is employment (lbs/employee/day or PED). Floor space, land use acreage and sales are occasionally used.

Industrial, commercial, and institutional rates can be separated by Standard Industrial Codes (SIC). These codes identify the industry a particular company belongs to. If waste stream composition could be correlated to SIC code and an activity measure, census data could be used to aggregate industrial and institutional market activities into measurable waste generation rates. Annual sales is another way to measure solid waste streams. In this type of analysis, companies are separated into categories that represent various levels of annual sales.

For reporting waste stream size, two types of measurement may be presented-size by weight, and size by volume. Although solid waste is usually characterized by weight, information about volume is important for such issues as determining how quickly landfill capacity is being filled and identifying the rate at which the volume of various materials in the waste stream is changing (U.S. Environmental Protection Agency, 1990).

Table 1 compares materials generated in U.S. municipal solid waste in 1988 by weight and volume. Column three of this table gives a ratio of volume to weight

for each material. A ratio of 1.0 means that the material occupies the same proportion by volume as by weight. Values greater than 1.0 mean that the material occupies a larger proportion of volume than weight. Plastics, metals, and "others" all have ratios greater than 1.0. By contrast, yard waste and glass each have ratios less than .6, indicating these materials are quite dense and occupy proportionately less volume than weight in landfills (U.S. Environmental Protection Agency, 1990).

Volume estimates of solid waste are more difficult to make than weight estimates. A pound of paper is a pound of paper whether it is in flat sheets, crumpled into a wad, or compacted into a bale, but the volume occupied in each case will be very different. Table 1 presents estimations of the volume of materials as they would typically be found in a landfill (a significant amount of compaction occurs in a landfill). These estimates are based largely on empirical data that are then used to estimate density factors (pounds/cubic yard) for components of solid waste under simulated landfill conditions, with corroboration from actual landfill studies (U.S. Environmental Protection Agency, 1990).

By volume, the paper and paperboard category ranks first in volume of MSW discarded (34 percent). Plastics rank second in volume, at 20 percent of the total, and yard wastes are third, at 10 percent. Paper and plastics combined account for over one-half of the volume of MSW discarded in 1988. By weight, the largest component of MSW is also paper and paperboard, at 40 percent of generation. However, by weight, yard wastes are the second largest component (roughly 18 percent of generation), and four of the remaining categories- glass, metals, plastics, and food wastes- range between 7 and 9 percent each by weight of total MSW

generated (U.S. Environmental Protection Agency, 1990).

Table 1. Materials Generated in U.S. MSW by Weight and Volume, 1988

Material:	Percent and amount of MSW Stream by Weight:	Percent and Amount of MSW Stream by Volume:	Ratio (vol%/ wt%)
Paper:	40% 71.8 million tons	34.1% 136.2 million yds^3	.85
Plastics:	8% 14.4 million tons	19.9% 79.7 million yds^3	2.5
Metals:	8.5% 15.3 million tons	12.1% 48.3 million yds^3	1.4
Yard Wastes:	17.6% 31.6 million tons	10.3% 41.3 million yds^3	.59
Glass:	7% 12.5 million tons	2% 7.9 million yds^3	.29
Other:	11.6% 20.8 million tons	18.4% 73.4 million yds^3	1.6
Total:	179.6 million tons	400 million yds^3	

(U.S. Environmental Protection Agency, 1990)

Solid Waste Disposal Methods and Issues

The available capacity and operating costs for waste disposal facilities will be strongly affected by state and federal regulatory initiatives. This includes eliminating facilities that are environmentally unsound and increasing the requirements for location, design and operation of new disposal facilities. As a result, landfills are becoming scarce across the nation, and landfill disposal costs will continue to increase (Resource Recycling Systems Inc., 1990).

Table 2 illustrates the management of MSW in the U.S. during 1988. Landfilling represented nearly 73% of the handling of MSW. Recovery of materials

for recycling was 14% of the total generation, and recovery for combustion was 14% (U.S. Environmental Protection Agency, 1990).

Table 2. Management of MSW in the U.S., 1988

METHOD:	PERCENTAGE:	TONNAGE:
Landfill	72.7%	130.5 million tons
Recovery	13.1%	23.5 million tons
Incineration	14.2%	25.5 million tons

(U.S. Environmental Protection Agency, 1990)

The Environmental Protection Agency has defined a hierarchy for waste disposal goals that many states and industries are adopting. First is the reduction of waste stream size. Second is the reuse of materials. Third is recovery for recycling, fourth is recovery for or incineration. Recovery for recycling and incineration are for those materials that cannot be reused or eliminated from processes. Last on the list is landfilling.

The State of Michigan has a Solid Waste Management Policy, with the goal of promoting waste reduction, reuse, composting, recycling, and incineration with energy recovery, while limiting landfill use. Landfilling of solid waste is the last choice of the Michigan solid waste management policy. However, landfilling is necessary for handling residuals that are not diverted to reuse strategies, and for incineration residues. Landfilling is not a popular waste disposal method and a stronger focus will be on recycling in the future. Table 3 shows a range of solid waste alternative goals, to be achieved by the year 2005. These are expressed as the

percent of the solid waste stream which should be diverted to each method.

Table 3. Resource Recovery Goal

Technology:	Range:
Waste Reduction	8 - 12%
Reuse	4 - 6%
Composting	8 - 12%
Recycling	20 - 30%
Incineration w/energy recovery	20 - 30%
Landfilling (current. 85-90%)	10 - 20%

(Michigan Department of Natural Resources, Resource Recovery Section, 1987)

All of these goals are considered integral components of a comprehensive solid waste management system. Note that they also follow the EPA's hierarchy of goals, from waste reduction to landfilling, in which the first priority for receiving state funds should be the simplest, most cost-effective alternative.

Many companies and states have continued to follow patterns contradictory to the EPA hierarchy. When considering waste disposal methods in an effort to reduce costs, long range transportation to lower cost landfills is usually the first option. Next is incineration in waste-to-energy facilities. Finally, they will consider waste reduction, recycling, and composting. Therefore, the main factor in the trend toward increased recycling will be rising cost of waste disposal (Michigan Department of Natural Resources, Resource Recovery Section, 1987).

From 1982 to 1987 some 3,000 landfills closed in the U.S.; 50% of the landfills now in use will close in five years. Landfills are designed to be in use for only 10 years and they are not being replaced. Texas was awarding 250 permits per year in the seventies, now they award only 15 per year. Ohio, Pennsylvania, West Virginia,

Virginia, Kentucky, Tennessee, New Jersey, and New York will run out of landfill space in less than five years (Glenn, 1990).

Even landfills deemed safe can be found to contain toxic materials, as this occurred in Delaware. In the congested Northeast, or areas with a high water table, there may be no room for additional sites. Landfilling issues are twofold: One concern is economic, which includes transportation and landfilling costs; and one is political. Citizens and politicians are sometimes placed into groups such as "NIMBY" (Not in My Backyard), "GOOMBY" (Get Out of My Backyard), "LULU" (Locally Undesirable Land Use), and "NIMEY" (Not in My Election Year) (Glenn, 1990).

While most plastic recycling has occurred at the industrial level, the recovery of post-consumer plastics is becoming more common. Currently, most PS foam is landfilled due to the lack of recycling programs (Franklin Associates, 1987). In 1988, only about 1.1 percent of all plastic waste was recycled. The bulk was polyethylene terephthalate (PET) and high-density polyethylene (HDPE). In some instances, states such as Michigan recover high amounts of PET due to state deposit laws. Most programs were exclusively drop-off. However, today curbside recycling programs are being implemented regularly in communities. As community demand adds an increased variety of recovered plastics, this number will continue to increase (Franklin Associates, 1987).

In Michigan, each community is allowed to use the mix of technologies that best fits its needs and preferences. After selection, the community works closely with the state government to interpret and adjust the statewide goals to meet local

problems and opportunities. By evaluating their county's waste composition data, present and projected disposal costs, and availability and distance to recycled materials sources, each community can determine the most appropriate goals for its plan (Michigan Department of Natural Resources, Resource Recovery Section, 1987).

Incineration

Combustion of MSW ranks behind recycling and composting in the solid waste management hierarchy. Most of the MSW combustion in the U.S. incorporates recovery of an energy product (generally steam or electricity); sale of the energy helps to offset the cost of operating the facility. In past years, it was common to burn municipal solid waste in incinerators as a volume reduction practice; recovery of energy started to become more prevalent in the 1970s. Combustion of MSW has increased rapidly since 1985, with numerous new facilities coming into operation. It was estimated that 24.5 million tons of MSW were combusted with energy recovery in 1988 (U.S. Environmental Protection Agency, 1990).

When MSW is combusted, a residue (usually called ash) is left behind. Years ago this ash was commonly disposed of along with MSW, but combustor ash is no longer classified as MSW. As a general "rule of thumb", MSW combustor ash amounts to about 25 percent (dry weight) of unprocessed MSW input. This percentage will vary from facility to facility depending upon the types of waste input and the efficiency and configuration of the facility (U.S. Environmental Protection Agency, 1990).

Incineration can be compared to landfilling and other methods of disposal by

cost, energy producing potential, and environmental concerns. Incinerators sometimes attract as much negative attention as landfills. Recovery of energy, when compared to economic benefits of recycled materials, especially plastics, is not currently beneficial. In 1988, approximately 155 incinerators were in operation, including at least three in Michigan, but 64 had been blocked or canceled. Their problems were part economic, with construction costs up to $500 million with non-competitive energy production. They were also in part technical, including the toxicity of residuals such as volatile and ash (Kampouris, Papaspyrides and Lekakou, 1988).

However, many scientists believe that incineration can work safely, that too many operators see the environmental issues as public relations concerns, rather than serious calls for upgrading practices. DuPont Corporation says that energy from burning waste currently landfilled in Canada could run every vehicle and heat every home in the country for two weeks every year. Canada currently produces some 32 million tons per year of waste, of which only 5% is burned. DuPont claims that the technology exists for the safe incineration of tires, plastics, and other wastes, and to capture a significant part of the energy released. In 1988, 15% of MSW was burned in the U.S. (Hocking, 1991).

In Japan, incineration processes combust cleanly, and are widespread due to limited space. However, of more than 2000 incinerators in operation, relatively few are designed to convert waste to energy. Many professionals agree that energy from combustion is important, and if implemented, more useful than material recovery. Contrary to common perceptions, technology to incinerate safely has progressed

considerably in recent years (Hocking, 1991).

Incineration is opposed by Pollution Probe, a Canadian environmental group, on the grounds that it is so capital intensive that it will work against the goals of reduction, reuse and recycling, by creating a demand for garbage. It is also opposed on the grounds that it will contribute to global warming, by putting more carbon dioxide in the air. DuPont, which currently incinerates about 84% of its waste, counters with the obvious point that by burning waste, less oil and natural gas will be burned (Hocking, 1991).

Solid wastes represent a potential source of raw materials as difficulties arise in the proper utilization of depleting resources. For plastics, although they constitute a small proportion of the domestic refuse (5-7%), large economic losses are involved because of their high cost. In fact, though plastic wastes can serve directly as a combustion aid for burning other organic refuse, their value as reclaimed plastic is considerably greater than their value as an energy source. Accordingly, well known destructive techniques, such as incineration or pyrolysis, seem quite wasteful. Incineration will remain a heavily disputed issue for years to come (Kampouris, Papaspyrides and Lekakou, 1988).

Recycling

Recycling is the alternative many consumers and companies alike are currently choosing. Since it poses little if any additional environmental danger and has been found to be economically feasible in many communities, many consider this to be a good near term alternative to solid waste problems. This is especially apparent in

industries where waste reduction and reuse cause difficulties. Recycling is rapidly becoming popular throughout the country. Nine of the ten most populous cities now have curbside collection, with the exception of Detroit which currently has high utilization of an incineration facility and is proposing the construction of another. This also illustrates how residential waste recycling has become a political necessity in every big city. The combined recycling budget for the 10 largest cities totals more than $162 million (Watson, 1990). New recycling projects are getting started and the government is becoming more involved.

Table 4 explores curbside recycling program development in large U.S. cities. In some cities like New York and Los Angeles, programs are well established and are growing at a fast rate. Other cities like Chicago and Houston have started pilot programs which are also expanding. The expected growth of residential recycling programs in the 10 biggest cities over the next 3 years is tremendous. The increase in targeted households is approximately 48% for New York, 600% for Los Angeles, and 580% for Chicago, with high figures for the others as well (Watson, 1990). This trend has an important implication for companies starting recycling programs. With the expected growth in recycling programs, there will be a great amount of publicity influencing more people to recycle. Thus, firms starting recycling programs now will have an environmental and public relations advantage.

Table 4. Curbside Recycling Programs in the Nation's 10 Largest Cities

CITIES	Current households targeted	Households targeted for 1993
New York	1,800,000	3,400,000
Los Angles	100,000	720,000
Chicago	62,000	651,000
Houston	27,000	400,000
Philadelphia	169,000	Undetermined
San Diego	80,000	Undetermined
Dallas	14,000	Undetermined
Phoenix	11,000	At least 21,000
Detroit	None	None
San Antonio	16,100	Undetermined

(Watson, 1990)

Note: Participation figures are for standard curbside materials such as paper, metal, glass and plastic containers. Yard waste collection is not included. New York's total includes collection from high-rise apartments.

Economic considerations, which are a driving force toward increased recycling include: the need to develop alternative sources of raw materials, the dollar value from the sale of recovered materials, the avoidance of disposal costs, the increasing cost of landfill development and operation, and the existing or potential hidden costs of landfilling such as groundwater contamination and cleanup costs.

In Michigan, recycling could work effectively in every part of the state according to 11 recycling feasibility studies that were conducted under the Clean Michigan Fund program. However, most county 641 plans did not accept recycling as a viable technology because of poor markets for recycled materials. This was

partly due to the recession, when the data was originally gathered (Wright, 1987).

The mix of collection technologies used in each region, county, and municipality may include curbside collection, collection at multi-family dwellings, drop-off centers, buy-back centers, mechanical and/or labor intensive sorting operations, centralized processing facilities, office paper recycling, used oil recycling, battery recovery and recycling, and textiles recovery and recycling.

Depending on the geographic, social, and economic factors of the community, certain technologies will work better than others (Michigan Department of Natural Resources, Resource Recovery Section, 1987). For recycling collection programs, the key issues in the decision to collect a particular material include source availability, accessibility of markets, materials shipping and processing requirements of buyers, market price and market demand. Most plastic recycling has occurred at the industrial level (Kent County Board of Public Works, 1990).

Table 5 shows U.S. waste stream generation, divided into four major categories that is estimated to be recovered for recycling by 1995. These categories are paper/wood, plastics, metals, and "others"- which represents all other waste stream materials recovered for recycling. By weight, paper/wood is expected to be the largest component recycled, at about 29 million tons. "Others" is expected to be second at 19 million tons, metals third at 4 million tons, and plastics last at .9 million tons. Note that although plastics is the third largest waste stream component, it is the smallest component expected to be recovered for recycling in 1995. Therefore, it will be important to focus on plastics recycling in the future, especially packaging materials, which comprise a large portion of plastics waste generation

(U.S. Environmental Protection Agency, 1990).

Table 5. Estimated 1995 U.S. Waste Generation and Recovery for Recycling

CATEGORY	WASTE GENERATION (million tons)	RECOVERY FOR RECYCLING (million tons)
Paper/wood	85.5	29.45
Others	62.2	18.6
Plastics	18.6	.9
Metals	16.2	4
TOTAL	182.5	52.95

(U.S. Environmental Protection Agency, 1990)

Evolution of Recycling Programs

Municipal involvement in recycling generally focuses on residential collection. Established firms then purchase the materials for shipping, further processing, or recycling into new products. In general, collected materials are processed further before being recycled by a manufacturer into a new product. This is most often by an intermediate firm which removes contaminants and densifies the material, or performs other processing. Participation tends to increase as programs mature and publicity increases (Lansky, 1991). Various plastics trade associations are available to help start plastic recycling programs. They include: The Plastics Recycling Foundation, National Association for Plastic Container Recovery, Council on Plastics and Packaging in the Environment and The Council on Solid Waste Solutions.

Marketing of secondary materials in general is often handled by brokers, who determine which manufacturers purchase recovered materials, and provide market

specifications to the seller. Manufacturers generally prefer to deal with brokers because quality control is better ensured and significant volume is guaranteed. However, material collectors may be able to deal directly with manufacturers if a large enough volume can be assembled.

Separation of Solid Waste

The separation of recyclable materials from the waste stream can be done either at the source (household, office, or business) or on a larger scale at collection or processing facilities (site-separation). Source separated collection systems include drop-off and buy-back centers, curbside collection, and multi-family or commercial office collection services (Resource Recycling Systems Inc., 1990). Separation enables recyclers to conveniently pick-up and transport materials for recycling. If materials are not separated, recyclers face the additional task of sorting through solid waste to locate materials for recycling. Levels of participation vary by industry and company size.

In order to divert substantial amounts of residential solid waste, curbside collection of recyclables is necessary. To sustain high participation rates, public education and promotion are needed. There are increased opportunities for local waste haulers to provide this service. Haulers can encourage recycling by using a variable collection fee for recyclables or by providing separate collection of recyclable materials (Michigan Department of Natural Resources, Resource Recovery Section, 1987).

The waste management industry is recognizing that in the future, recycling can

be an essential component in any "least cost" solution. It is compatible with other disposal system options, results in reduced transportation costs at transfer stations, reduces landfill costs, and can eliminate several types of pollutants from waste to energy facilities. As a result, more waste management firms are creating the capability to offer recycling programs to their target sources (Resource Recycling Systems Inc., 1990).

PS Foam Waste Management Issues

Residential waste generation rates for PS foam in Michigan are not available. PS foam is a small component of MSW (municipal solid waste). Residential recycling studies show that it can take weeks for a household to collect enough PS foam to fill a bag, and have estimated that only 2% of the plastics collected are PS foam. In addition, there have not been any studies of industrial, commercial and institutional generation of PS foam. However, estimates from total MSW studies indicate between .5% to 2.1% of total MSW is polystyrene (all types) (Hocking, 1991).

PS Foam Recycling

For PS foam, The National Polystyrene Recycling Company has defined the following as potential sites for PS foam collection: corporations, military bases, cafeterias, restaurants, community drop-off centers and curbside collection, stadiums, hospitals, school districts, universities, fast food restaurants, prisons, airports, manufacturing plants, retail stores and shopping malls. The NPRC recommends

implementing a PS recycling program in phases. The first is to target high volume users like schools and universities, and launch heavy public awareness programs. The second phase is in fast food and where festival types of events take place. This is because a separate type of education is required. The third phase is voluntary drop-off and curbside collection as these require the most advanced consumer awareness and education (National Polystyrene Recycling Company, 1991).

A recycling plan is never successful without the participation and acceptance of the audience. To reduce the myths about PS foam, education is crucial. The PS recycling program should be planned in advance and information about the start of this program should be publicized effectively.

Students and employees should be involved as much as possible. It is a good idea to give student bodies and work force teams the responsibility for planning and carrying out the promotion of the program. Newsletters should be used, and as many people as possible should be involved (National Polystyrene Recycling Company, 1991). Children in over one hundred schools are learning about recycling at lunch when they separate their polystyrene cups, trays and glasses in different containers. Students participate by stacking their polystyrene trays in special designated areas (The Polystyrene Packaging Council, 1991).

In companies and institutions, an enthusiastic campaign should be developed by creating a display of recycling literature, and products made from recycled polystyrene. Employees should be made aware of the start of the program and if possible, they should be involved in running the program. Choosing an effective recycling group is very important for the effectiveness of the program. The group

should be able to take over day to day responsibility of operation after initial start-up. People who have a high level of environmental consciousness and motivation should be selected (The Polystyrene Packaging Council, 1991).

Virgin and Recycled Uses and Markets for PS Foam

Although polystyrene is technically recyclable, the economic feasibility is questionable. Residential collection of PS foam is rare. This is because there is little polystyrene available in residential areas, and transportation and sorting are costly. It is important to perform a cost-benefit analysis before starting a residential polystyrene collection program. A nine month (April-Dec. 1990) PS foam recycling pilot project has been successfully implemented in a regular residential curbside collection program in Fitchburg, Wisconsin (Gruder-Adams, 1990).

FDA regulations limit food applications for recycled materials, but there could be significant applications of recycled PS foam for packaging, insulation and construction. This is particularly significant since packaging and construction use 24.2% and 19.6% of plastics respectively (Heathcote, 1991). PS foam can also be recycled back into use as office trays, building construction, splinterless lumber, flower pots, speed bumps, picnic tables and insulation in winter coats. For example, Lin Pac is producing CFC-free insulation blocks from reclaimed PS foam, however, the loss of McDonald's as a supplier may affect this application (Heathcote, 1991).

Virgin applications of foamed polystyrene are in cups, bowls, plates, trays and "clamshell" containers. PS foam is also used as protective packaging for fragile items like electronics. The primary PS foam consumer product packages include the

trays for meats and produce, egg cartons, and containers for various kinds of processed food. Since many of these containers package food items, environmental concerns could affect their use as recycled products, limiting their growth. Growth limitations for recycled PS foam content in food products may be solved by increasing non-food PS markets. For example, allowing appliance components to replace acrylo-nitrile-butadine-styrene (ABS) with PS foam would increase a non-food PS foam market. Other food applications, such as placing a recycled layer of recycled PS foam to be in between two virgin PS foam layers, have been considered. Although not FDA approved, some Hardee's restaurants currently use this material in their clamshells (Lashinsky, 1991).

Table 6 shows that both virgin non-foamed and foamed PS have large markets. Therefore, recycled markets may also have large potential. Non-foamed polystyrene can be used for food packaging such as yogurt and cottage cheese containers, and clear plastic salad bar containers. It also has consumer uses in video cassettes, hangers, flower pots, office equipment, TV and computer housings, auto parts and marine construction materials. Other large non-foamed polystyrene uses include park benches, speed bumps, playground equipment and traffic signs (The Polystyrene Packaging Council, 1991).

Table 6. U.S. Polystyrene Resin Sales by Process (mil. lbs./yr.)

Year:	1988	1989
Molding (solid PS):	1849	1829
Extrusion:		
Solid PS	1380	1375
PS foam	799	781
Expandable Bead:	633	733
Export:	161	208
Other:	202	258
TOTAL	5027	5184

(Modern Plastics, 1990)

Alternative Materials to PS Foam

Alternative, more "environmentally friendly" materials may be considered when developing waste management solutions. Although PS foam is recyclable, companies have explored other options. The current price offered for recycled PS foam is approximately $.20 per lb., while virgin material is about $.50 per lb. In order to maintain quality standards, PS foam should contain no more than 20% recycled product. This percentage should increase as the technology improves (Hocking, 1991).

Polypropylene (PP) is becoming a major competitor against many types of PS food applications. Currently, major competition occurs in the non-foamed sheet product with PP replacing PS foam in cups, containers for dairy products, and lids of all types. Because of the competition, the non-foamed uses are forecasted to grow slower than the total polystyrene consumption. Consumption of this form of PS foam

packaging has been predicted to decline in the 1990's (Hocking, 1991). Companies are considering polypropylene's price per lb., slightly below 50 cents, and its environmental friendliness, which underestimates polystyrene's recyclability. Meanwhile, polystyrene competitors continue to promote polypropylene as a better environmental alternative.

Other polymer competition occurs in packaging, which accounts for a third of polystyrene consumption. The other major packaging uses require foamed forms, which are initially fabricated as foamed sheet and expandable beads. Polypropylene has already been introduced as an alternative, another alternative is non-recyclable paper-based products. Many argue that paper-based these products favor waste reduction. However, in the case of recyclability and energy consumption, they are not viable substitutes. Table 7 compares paper-based cups and PS foam cups in terms of raw material usage, utility usage, water effluent and disposal. Results show that paper-based materials are not as environmentally friendly as consumers perceive them to be (Hocking, 1991).

Table 7. Raw Material Summary for Hot Drink Containers.

ITEM	PAPER CUP*	POLYFOAM CUP**
RAW MATERIALS/CUP:		
Wood and Bark(g)	33 (28-37)	0
Petroleum fractions(g)	4.1 (2.8-5.5)	3.2
Finished Weight	10.1	1.5
Wholesale Cost	2.5x	x
UTILITIES/METRIC TON:		
Steam (kg)	9000-12,000	5000
Power (kWh)	980	120-180
Cooling Water (m3)	50	154
WATER EFFLUENT:		
Suspended Solids (kg)	35-60	Trace
BOD (kg)	30-50	0.07
Organochlorines (kg)	5-7	0
AIR EMISSIONS:		
Particulates (kg)	5-15	0.1
Pentane (kg)	0	35-50
Recycle potential after use:	Low, hot melt adhesive and coating difficulties	High, resin reuse in other applications
ULTIMATE DISPOSAL:		
Proper Incineration	Clean	Clean
Heat Recovery (MJ/kg)	20	40
Mass to Landfill (g)	10.1	1.5
Biodegradability	Yes	No, essentially inert

* Made from fully bleached kraft pulp

** Made from molded polystyrene foamable beads.

(Hocking, 1991)

Future PS Demand

Increases in U.S. demand for polystyrene have been 2 to 2.5% per year, below the historical average of 3%. However, new polystyrene manufacturing plants continue to be built, and some existing plants are adding capacity. Added capacity combined with depressed demand means that extra capacity is not used. To regain unused capacity, manufacturers are expected to lower selling prices for most grades and kinds of polystyrene through the early 1990's (C & EN, 1989).

Interpolymer competition in packaging has contributed to the slowdown in consumption of all kinds of polystyrene. Competition from other alternative packaging materials such as paper and paperboard, polypropylene and reusable tableware, could further cut into polystyrene's growth.

Table 8 illustrates the estimated demand in 1993 for all kinds of polystyrene. World demand for polystyrene is expected to grow an average of 4.6% annually between 1989 and 1993. In 1988, world demand increased 6-7%, to 16.4 billion lbs. By 1993, world demand for polystyrene will total 20 billion lbs., with 85% of this demand from North America, Western Europe, and the Asian/Pacific area. World capacity to make polystyrene is expected to grow 8.4% annually between 1989 and 1993, which is slightly faster than demand, amounting to 22.6 billion lbs (C & EN, 1989).

Table 8. Polystyrene World Demand in 1993

Region:	Pounds-billions:
Asia/Pacific	6.0
North America	6.0
Western Europe	5.0
Eastern Europe	1.8
Africa/Middle East	0.6
Latin America	0.6
TOTAL	20.0

(C & EN, 1989)

Asia/Pacific, North America and Western Europe combine for 85% of the estimated 1993 world polystyrene demand. However, based on estimates of production and capacity, the average operating rate will slip to about 87% of capacity, down from about 90% during 1988. Capacity utilization will drop further in the 1990's to about 80% unless some is shut down. Industry sources speculate that some of the smaller and older units of both large and small producers could shut down during the 1990's due to lack of specialty grades that sell for higher prices (C & EN, 1989).

Seasonality of PS Foam and Solid Waste

Seasonal variations in waste generation and recyclable material rates must be considered in planning facilities to meet peak processing requirements. Although no information exists for PS foam, peak solid waste disposal times occur during the fall. Some of the factors affecting variation include cycles in industrial production and retail activity, periods of school attendance, periodic special pickups for large, bulky

items, higher generation of grass clipping during summer months, and collection of leaves in the fall. In general, waste generation rates peak with business cycles, in the fall (Michigan Department of Natural Resources, Resource Recovery Section, 1986).

Seasonality has been estimated for some SW Michigan counties. Oakland County has estimated a peak monthly generation rate at 130% of average monthly waste generation, with a minimum at 70% of average monthly generation rate. Oakland County was shown to peak in November and it bottomed out in February. Seasonality was also tracked at landfills in three other Michigan counties, which included Washtenaw, Wayne and Macomb. The results from these counties were similar to Oakland county. Waste generation peaked in the fall, and the smallest waste generation occurred in the winter (Michigan Department of Natural Resources, Resource Recovery Section, 1986).

Curbside Collection of PS Foam and Solid Waste

In the Fitchburg, WI research, the recycling coordinator testified at a state hearing that from a municipal standpoint, PS foam could be called "recyclable" only if the costs of collection, processing and transport were offset by revenue from material sales (Gruder-Adams, 1990). This nine-month curbside collection project for all kinds of waste was funded by Amoco. Its purpose was to learn more about the amount of PS recovered from the residential sector. Measurement methods included weight and volume, participation as assessed by using bar coding and computer scanner, and set-out frequency. How PS recycling affects collection efficiency and route/time factors, contamination levels, and processing needs for

residential PS foam were also analyzed.

Fitchburg's over 3000 households are currently in their third year of separating newsprint, mixed paper, glass, steel aluminum, HDPE, and PET for collection purposes. For the PS foam project, residents were requested to rinse any PS foam package and place it in a plastic bag in reserved plastic bins. Residents set out polystyrene egg cartons, meat/produce trays, packaging material, clamshells, cups and rigid containers. Residents received environmental education through packets containing information brochures. In addition, they were given 35 clear 17-gallon bags with instructions and a logo printed on them. All the PS foam bags were kept separate on the truck and were taken to the Madison Recycling Center where they were stored in pallet boxes. When processed, PS foam was debagged and sorted, the contaminated portion was washed and dried, then the scrap was granulated. Some of this end product was used locally with the rest exported to China (Gruder-Adams, 1990).

In the Fitchburg, Wisconsin PS recycling project, the number of bags of PS foam that were collected fluctuated between 937 and 1621 (See Table 9), and within the first four months 2.64 tons of PS were recovered. 83% of the households participated in the pilot project, while 11% of the households set out materials in the bags weekly. The set out rate was low because it can take months for a household to accumulate enough PS to put out a bag. The frequency with which residents participated in setting out PS foam was lower than any other material collected (Gruder-Adams, 1990).

Table 9. Curbside Polystyrene Collection Pilot Program, 1990

Month:	# of Bags	Volume (cu. yds)	Weight (lbs)	Participation Rate
April	937	937	50	26%
May	1,621	1,656	60	59%
June	1,298	1,306	50	73%
July	1,512	1,550	43	83%
Total	5,368	5,449	202	83%

(Gruder-Adams, 1990)

Commitment and understanding the value of PS foam by all residents, and grocery and fast food retailers played an important part in making the program a success. Of the majority of the population participating, 61% put out PS foam one time in 15 weeks, 24% put it out twice in the same period, and 8% set out material three times. The highest number of PS foam set-outs by any household was nine times in 15 weeks.

Curbside recycling programs have associated costs and strategies to increase participation and reduce costs. The costs associated with the Fitchburg program included bags, collection, intermediate processing, shipping, densifying, pelletizing, and marketing. In the pilot project, polystyrene was collected weekly with other recyclables. Participation tends to increase with frequency in pick-up, e.g. weekly vs. monthly. Participation will also increase when recyclables are picked up on regular trash day. The PS collected during the first four months of the above project was analyzed with the following results. 24% collected was trays from meat, 12% collected was takeout containers, 6% was plates and 6% was egg cartons. All other

categories of PS foam were negligible (Gruder-Adams, 1990).

Residential PS foam collection is not being done by many recyclers. This is because there is less polystyrene available in residential areas and it takes time for people to participate in these programs. It is important to perform a cost-benefit analysis before starting a residential polystyrene collection program.

PS Foam Recycling, Processing and Transportation Costs

Companies show mixed attitudes about the extent to which they will incur the costs of recycling and related transportation methods. With solid waste landfilling options physically limited, recycling costs will not have to be drastically low to offset the increasing costs of landfilling. Transportation costs for recycling should remain proportional with those for landfilling. Legislation could act as a catalyst to stimulate landfilling alternatives. The Michigan Solid Waste Management policy, which was adopted by the Michigan Natural Resources Commission on May 26, 1988, emphasizes reuse, waste reduction, recycling and composting as the primary focus of state funding (Michigan Department of Natural Resources, Waste Management Division, 1987).

Although the policy is primarily concerned with non-hazardous materials, it recommends legislation and state financial assistance to encourage the expansion of household and commercial waste management programs. This plan is a long-term strategy that emphasizes the responsibility of business leaders and citizens. The strategy depends on positive and incentive approaches, not on a set of mandatory requirements. However, mandatory requirements may be pursued if major changes

in behavior do not occur voluntarily (Michigan Department of Natural Resources, Resource Recovery Section, 1987).

In many cases, recycling facilities do not have to pay for the materials collected for recycling. For example, the University of Miami (Ohio) now receives $.20/lb. for PS collected, up substantially from $.04/lb. (Lansky, 1991). In 1989, Plastics Again in New York, paid 5 cents a pound for deliveries that were at least 98% polystyrene by weight. It accepted less than clean containers which may have been contaminated by a wide variety of foods, textiles and metals, but charged a fee of up to 24 cents a pound for fast-food restaurants that performed little sorting. The key equipment in the design of Plastics Again's facility is a $500,000 twin screw extruder. Their work-force is largely Vietnamese immigrants supplied by an employment agency at $7.50 an hour (Feder, 1990).

There are many factors to be considered when evaluating recycling costs. Recycling technologies that are used in the collection of materials may include a mix of curbside collection, drop-off, or buy-back centers, multi-family collection, commercial collection, on-call collection, or site separation of mixed waste. The appropriate mix of technologies to be used will depend on the community involved.

Commingled curbside programs are believed to recover more and better quality material while requiring less support to operate. Collection costs to be accounted for include route rate, average miles in the route, route velocity, site stops, pick-up quantity, productivity, product density, trailer rental, trailer capacity, interplant distance, and waste rate. On-road collection costs can dramatically effect operational costs. Scheduling routes by computer to minimize haul and travel time

for institutional, residential, retail, and industrial areas is most effective (National Polystyrene Recycling Company, 1991).

PS recycling requires a different marketing approach than initially conceived. In the past, recycled PS foam marketing primarily utilized a "pull" strategy which assumed that the market would initiate demand for recycled PS, and beat a track to the recycler. This did not happen for a number of reasons including: lack of awareness, concerns about quality, and poor understanding of the economics. This market strategy should shift to more of a "push" effort if PS foam recycling is to be viable as a stand-alone enterprise. This "push" effort should include more active marketing, sales and education efforts. This implies that marketing, sales, and education must be adequately budgeted for when developing a PS foam recycling model. Marketing and sales efforts should work to develop long term contracts. The contracts must focus on quality and consistency as well as price (National Polystyrene Recycling Company, 1991).

Processing and collecting materials for recycling is simplified by the use of densifying (compacting) machines. In Mason, MI, Dart Container Corporation has created a densifying machine that may be leased or purchased outright by interested recycling participants. The machine serves to make PS foam more compact for back-hauling purposes, thereby reducing transportation costs dramatically. Densifiers are also used for other materials that are recycled such as aluminum cans. Many facilities now have the option of cheaper disposal methods, such as contracting for landfilling. Therefore, densifiers are not very popular.

Source and site material separation for recovery of materials for recycling is

also useful. The most cost effective method for site separation is when it occurs at the source of the disposed materials. However, site separation of recyclable materials is usually conducted at processing facilities, landfills or transfer stations. Manual labor and/or processing equipment is used to sort materials. Commercial loads are usually targeted for sorting due to greater volume of certain materials. Site separation programs normally target old corrugated containers, although glass, metals and other paper products are recovered by some. A few examples of site separation facilities and the amount of material recovered are shown in Table 10.

Table 10. Site Separation Recovery Level

Location:	Type:	Total Waste Received (tons/day)	Total Waste Separated (tons/day)	Percentage
Grand Rapids, MI	Landfill	28	13	46.4%
Eureka, CA	Landfill	200	16	8.0%
St. Catherines, Canada	Landfill	300	10	3.3%
Ocala, FL	Transfer Station	200	23	11.5%
Seattle, WA	Transfer Station	450	14	3.1%
Huntington Beach, CA	Transfer Station	1,100	40	3.6%

(Michigan Department of Natural Resources, Resource Recovery Section, 1986)

Environmental Attitudes and Perceptions

Attitudes and perceptions companies and consumers have about the environment and solid waste are important when considering whether programs such as reduce, reuse and recycle will work. Costs, landfill space, education, public relations, and legal mandates are important issues companies face. Environmental education is the most critical key to success of reduce, reuse and recycle programs (Gruder-Adams, 1990).

Long range publicity campaigns are now necessary when opening landfills or incineration facilities. Consumers and industry professionals seem much more focused on reduce, reuse and recycle, than landfilling and incineration alternatives. They are interested in the R-R-R hierarchy, but admit lacking a complete understanding of how these programs work and what the best options are (Gruder-Adams, 1990). This reinforces the need for strong environmental education programs within companies and communities.

Studies of recycling behavior indicate that participation also varies by pick-up frequency, income, education and age, economic incentives, promotion and program maturity. The promotional strategy is particularly important in commercial, industrial, and institutional recycling programs.

One study was conducted to find the most effective recycling collection method for capturing the most recyclables, while also encouraging the highest participation rate. This study was conducted in the City of Everett, Washington. The first concern was weekly vs. monthly pickups. Should the material be picked up on weekly basis or monthly basis depending upon supply and number of pickup trucks?

The study found that participation increased with weekly pickups, especially when combined with regular trash pickup (Operational Research Society, 1987).

Socio-economic Recycling Program Participation Factors

Other participation factors consider socio-economic groups. This studies the different levels of income and education, spending power, and changes in consumption patterns. Socio-economic variables can determine the amount of materials that may be collected within a certain residential area. For example, results of data collection from Metro-Detroit found that residents from lower socio-economic neighborhoods contributed more recyclable materials per household under weekly collection with buy-back methods than residents from higher socioeconomic test areas. Lower socio-economic groups also had a greater participation rate in programs that had deposit laws for returnables such as cans, glass and plastic beverage containers. However, overall participation rates in environmental collection programs were greater in the higher socio-economic groups (Michigan Department of Natural Resources, Resource Recovery Section, 1986).

Participation rates of large vs. small businesses have not been studied. However, a correlation may be drawn to the geographic position of a business. For example, a business in a low socio-economic neighborhood may be less likely to participate in recycling programs than a business in a higher socio-economic area. The size of a business' parent company may also affect participation rates. Larger organizations tend to have more mature environmental programs. Therefore, participation in recycling programs will tend to be better within a business that has

more environmental education (Michigan Department of Natural Resources, Waste Management Division, 1987).

Participation will increase when special recycling containers are provided, as recycling programs mature, and if programs pick recyclables up at their source. Businesses prefer pick-up vs. drop-off recycling programs. Where drop-off is the only option, the distance from the business to the recycling facility or transfer station is a large participation factor. In general, business participation begins to decline when recyclables have to be transported to facilities more than 8-10 miles away. Increasing promotion in a recycling program will also increase participation (Michigan Department of Natural Resources, Waste Management Division, 1987).

Participation can be increased in communities where businesses and residents are charged on a variable basis for garbage collection, i.e. per bag, by allowing reduced charges for recyclables. A Kent County, MI study found a higher participation rate for residents who use the City Refuse Collection service, which uses a bag and tag system, and offers recycling bags at a lower cost as an incentive. In addition, mandatory recycling ordinances may increase participation by two-times the voluntary level with little enforcement, mostly due to media coverage (Kent County Board of Public Works, 1990).

However, legislation can have negative effects if implemented with poor planning. This was illustrated in Minneapolis, Minnesota. In 1989, legislation was passed that required all food products sold within the city limits to be packaged in an "environmentally acceptable" manner. According to the definition in the ordinance, environmentally acceptable meant returnable or recyclable packaging.

At the time, Minneapolis had a recycling program that could handle glass, paper, and aluminum, but not plastics. Therefore, to salvage the use of plastics in packaging, Minneapolis was forced to immediately come up with a plastics recycling program. Fortunately, a successful recycling program, including a $100,000 plastics collection vehicle was implemented on time. But a question remained: Had Minneapolis achieved a net gain for the environment?

Participation did increase dramatically, from 22% to 62%. However, political disputes prevented the construction of a materials reclamation facility (MRF)- the facility required to sort, clean, and prepare plastics for resale to end users. Minneapolis was left with plastics that couldn't be resold for use. With no connection to the marketplace, Minneapolis had problems deriving revenues that would offset the cost of the recycling program. Since the plastics were never converted to new products, there was no environmental gain- the plastics would still be disposed of as garbage. The lesson here is that authority without competence will not create environmental solutions. Programs must be planned very carefully (Lodge and Rayport, 1991).

3.0 RESEARCH METHOD

This research was sponsored as part of a larger project, conducted by the Michigan State University's Industrial Development Institute. The purpose of the larger project was to construct a computer model and business plan to evaluate the economic feasibility of a PS foam recycling facility for southeast Michigan (the Metro-Detroit area).

The role of the survey was to estimate the volume of PS foam available from various industrial, institutional and commercial sources. In addition, for the purpose of this thesis, questions were included regarding other waste stream components, recycling expectations, and attitudes about disposal. The larger project's group process imposed some constraints, but the financial support and intellectual input were invaluable to the completion of the survey.

The questionnaire was largely based on the literature reviewed in Chapter 2. Development was an iterative process, with input from the Industrial Development Institute's project group, this thesis committee, the MSU Center for Survey Research, and industry representatives. The survey consisted of 27 questions in the following areas: solid waste disposal methods and volume, disposal costs, incineration, recycling methods and volume, separation of materials, transportation and recycling costs, and participation and attitudes about environmental issues in general. Other

questions focused on various PS foam issues including: PS foam recycling feasibility and participation, waste stream composition, recycled uses, alternatives, future demand, seasonality, and potential contamination.

A random sample of 2000 companies was drawn from a Dunn & Bradstreet on-line database. This database contained all companies currently listed in southeast Michigan. The sample was stratified by SIC codes; half was drawn from firms expected to be "heavy users" of PS foam, like educational institutions and restaurants, and half from "light users", like banks and legal services.

The mail survey was administered to key informants at each site. The respondents were selected by first calling the firm and asking for the name of the person who purchases waste disposal services. About 8% of the companies contacted were no longer in business or chose not to participate.

The survey was professionally printed in booklet form. When mailed, all surveys were enclosed with a personalized and hand-signed cover letter, and printed return postage paid envelopes. After the surveys were mailed, a postcard was sent to all participating companies within four weeks as a reminder to return them, as recommended by Dillman.

The response rate was 10% or about 200 companies. For this type of research, professionals in the field of survey research deemed this response acceptable for statistical analysis. Since the people that responded were waste professionals within their companies, the results obtained from the survey are likely to be as accurate as possible. The people who responded were willing to take the extra time to compile the information.

The returned surveys were entered into a database compatible with the software used to analyze them. This was completed by Michigan State University's Center for Survey Research. The data was then statistically analyzed for this thesis, using the Statistical Package for the Social Sciences (SPSS), Version 3.1. Analysis was completed using cross-tabulations, mean tables, and frequency tables. Cross-tabulation statistics show the number of respondents from a particular group (i.e. sales or SIC) that chose a particular answer. Mean tables present means and corresponding variations. These were used in waste stream and other quantified analysis. Frequency tables show the percent of the entire responding population that chose a particular response.

Appendices are included after conclusions and recommendations (Chapter 5). Appendix A presents the original survey. Appendix B shows individual SIC analysis to questions that were presented with aggregate totals. For example, cross-tabulation may analyze a question by all 16 SIC groupings, but the results and discussion (Chapter 4) may present only aggregate results of the entire responding population. To explore the entire question containing individual results from all 16 SIC groups, refer to Appendix B.

Respondents may be categorized into SIC (standard industrial code), yearly sales, or aggregate frequency groups. When questions were analyzed, the category best suiting the question was used. An "SIC group" refers to the general industry a company belongs to. There are 16 different SIC groups used; each group may consist of one or a combination of SIC codes. In many cases, similar SICs were combined into groups to make results more statistically valid. Table 11 shows the

name for each group, the members of that group and the percentage that group comprised of the entire sample. The names given to groups of SICs are only to assist the reader when interpreting results, and may not necessarily represent the entire group. In general, questions that relate to perceptions about issues such as recycling, the environment, employees, etc. were analyzed by SIC groupings.

The second way questions were analyzed is by 6 sales groups, numbered 1-6. Each represents a different sales range. Group 1 has the smallest sales (<$99,000), and group 6 has the largest (>$1,021,000,000). Table 12 shows these ranges. This research analyzed questions requiring quantified analysis by sales ranges. For example, questions relating to the amount of solid waste disposed of by a company, the amount of materials that are recycled, etc. As illustrated by Table 11, the rather small sizes of individual SIC groups that responded to the survey prohibited waste stream volume analysis by industry. Therefore, to reduce variation as much as possible, waste streams and quantified questions were analyzed by the sales groups, which represent larger group sizes.

In some cases, it was not possible to gain statistical validity of a question for analysis by either SIC or sales groups. In this case, aggregate frequencies are presented. These simply represent the percent of the entire population that circled or filled in a certain response.

Each question is discussed and followed a table showing the statistical results. Method of analysis, i.e. sales, SIC, or frequency, will be listed at the top of the table. All tables have a row at the bottom to illustrate how many people from a particular group responded and how many people overall responded to that question.

Table 11. SIC Code Groups

Group Name:	Size:	% of Total:	Members:
Const.	13	7%	General building by contractors, heavy construction and trade construction.
Mfg.	37	19%	Food products, textile, apparel, lumber wood, furniture, food containers, printing, chemicals, rubber, leather, glass, metal, industrial machinery, electronics, transportation equipment, instruments and misc. manufacturing.
Whsle. Dur.	3	2%	Air transportation, communications and wholesale durable goods.
Whsle. Non-dur.	15	8%	Wholesale nondurable, building and garden materials.
Hshld.	19	10%	Food stores, service stations, apparel and home furnishing stores.
Rest.	7	4%	Eating and drinking places.
Retail	12	6%	Miscellaneous retail.
Banks	17	9%	Depository institutions, NOW depositories, brokers and real estate.
Entmnt.	22	11%	Hotels and lodging, business services, auto services, motion pictures, amusement and recreation services.
Health	1	.5%	Health services.
Legal	2	1%	Legal services.
Educ.	9	5%	Education services.
Social Service	6	3%	Social services.
Member.	21	11%	Membership organizations, engineering and management services.
Public Safety	1	.5%	Justice, public order and safety.
Others	9	5%	All others.
TOTAL:	194	100%	

Table 12 presents the number and size that corresponds to the given yearly sales figure. Groups were aggregated to obtain comparable group sample sizes, while maintaining a fair separation of sales figures.

Table 12. Sales Code Groups

Sales Group:	Size:	% of Total:	Yearly Sales (in $):
1	36	19%	0 to 99,999
2	46	24%	100,000 to 499,999
3	25	13%	500,000 to 999,999
4	37	19%	1,000,000 to 9,999,999
5	12	6%	10,000,000 to 1,021,000,000
6	38	20%	GREATER than 1,021,000,000
TOTAL:	194	100%	

Waste stream volume analysis presented in results and discussion (Chapter 4) was performed by separating respondents into the sales groups listed in Table 12. As previously noted, the size of the population that responded to the survey prohibited analysis by industry type. Table 13 shows the complete breakdown of the responding population. Each SIC group is listed with its respondents separated into the six sales groups. Note that the number of respondents per SIC sales group is rather small. This shows that waste stream analysis by industry (the SIC groups in Table 11), separated into sales groups (the sales groups in Table 12) would not be possible without a much larger response rate.

Table 13. SIC Groups separated by Sales Groups

	Sales Group:						
Group Name:	1	2	3	4	5	6	Row Total
Const.	2	6	1	1	1	2	13
Mfg.	2	7	3	15	4	6	37
Whsle. Dur.			1		1	1	3
Whsle. Non-dur.	3	4	2	2	1	3	15
Hshld.		5	7	5	1	1	19
Rest.	2	1	1	1		2	7
Retail	3	4	1	2		2	12
Banks	3	6	1	1	2	4	17
Entmnt.	7	5	4	3		3	22
Health				1			1
Legal	1			1			2
Educ.		1	2	4	1	1	9
Social Service	2	2				2	6
Member.	11	5	2	1	1	1	21
Public Safety						1	1
Others						9	9
Column Total	36	46	25	37	12	38	194

Limitations

The response size was large enough to report statistical means, standard deviations, cross-tabulation results, and frequency statistics. However, in many cases, it was not large enough to report, with confidence, comparisons between individual groups to see if one group differed significantly from the rest of the responding groups. These statistics would include analysis of variance (ANOVA), and chi-square

for normal distributions, and Kruskal-Wallis analysis for populations following non-normal distributions.

Statistical analysis between groups would be most useful if they were categorized by SIC groups, not sales groups. For example, SIC categorization could be used to see if manufacturing waste streams differ significantly from retailing industry waste streams. To increase statistical validity, questions had to be grouped according to company size, not SIC groups. Therefore, these comparisons were not possible. In addition, to perform analysis and view the differences between individual sales groups would not be useful for most of the questions presented. Finally, variances for most questions were very large. If individual comparisons between sales groups were made, it would be difficult to report them with confidence.

4.0 RESULTS AND DISCUSSION

Waste Disposal Methods and Costs

Table 14 shows that most respondents (84%) currently contract to have their waste transported to landfills. Therefore, many may not be able to supply transportation vehicles for waste disposal purposes. When transportation for recycling is introduced, twice as many companies, or 19%, contract for pick-up, versus the 8% who use their own transportation. 23% of the respondents recycle office paper and manufacturing materials internally. Table 14 also illustrates as company size increases, no more large companies transport waste for disposal than small companies.

Many companies of all sizes are contracting for waste and recycling disposal. In the future, transportation costs that contractors pass on for waste disposal and recycling will be an important concern. If recycling facilities can reach breakeven to cover overhead expenses, recycling may become a waste disposal favorite in economic terms. However, since companies are very dependent on contractors, recycling will have to gain strong contractor support. Many contractors own the landfills, and they may resist recycling efforts.

Table 14. Solid Waste Disposal Handling

Q1. How does your facility handle solid waste now? ***(Indicate all that you currently use.)***							
	GROUP (BY SALES)						
RESPONSE:	1	2	3	4	5	6	TOT
1. We collect and transport our waste to landfills	4%	9%	15%	15%	9%	12%	11%
2. We collect and transport waste to recyclers	15%	7%	5%	6%	0%	9%	8%
3. We contract with a collection company for disposal to landfills	79%	77%	83%	94%	91%	82%	84%
4. We contract with a collection company for recycling	4%	11%	30%	15%	64%	26%	19%
5. We recycle internally ..	26%	23%	30%	15%	27%	24%	23%
GROUP TOTAL	27	44	20	34	11	34	170

Table 14 illustrated that a large number of companies currently contract for disposal to landfills. In addition, Table 15 shows that a very large percentage (74%) of their total waste stream is reaching landfills. Currently, only 10% of all respondents sell or give materials for recycling. Although large companies may have more resources available to participate in environmental programs, they reported no higher participation than smaller companies.

The amount of solid waste reaching landfills will have to be reduced dramatically in the very near future. Waste stream reduction, re-use of materials, recycling, and incineration are important components for future waste stream management.

Table 15. Solid Waste Sold, Incinerated, Recycled and Re-used

Q2. Please break down by percentage what happens to your facility's solid waste. If percentages are not available, please give your best estimate:								
		GROUP (BY SALES)						
RESPONSE:		1	2	3	4	5	6	TOT
1. Amount of solid waste that reaches landfills .	MEAN:	78%	74%	74%	70%	74%	76%	74%
	STD. DEV.:	29%	38%	33%	35%	27%	34%	33%
2. Amount that is incinerated	MEAN:	6%	8%	10%	9%	0%	1%	6%
	STD. DEV.:	20%	23%	25%	24%	0%	4%	20%
3. Amount sold or given to companies for recycling	MEAN:	6%	10%	9%	10%	6%	16%	10%
	STD. DEV.:	12%	23%	17%	24%	13%	28%	21%
4. Amount that is office paper in recycling programs	MEAN:	9%	1%	5%	8%	14%	4%	6%
	STD. DEV.:	21%	3%	16%	23%	19%	15%	17%
5. Amount that is reused in manufacturing . .	MEAN:	1%	.5%	4%	2%	2%	0%	1%
	STD. DEV.:	5%	2%	17%	4%	6%	1%	7%
6. Other methods	MEAN:	1%	5%	.5%	1%	2%	0%	2%
	STD. DEV.:	4%	22%	2%	5%	5%	1%	11%
GROUP TOTAL		31	39	24	32	11	37	174

Table 16 shows that, in general, the tonnage of waste discarded by companies increases with their size. The disposal costs (Table 17) also increase with their size. Hence, a direct relationship between company size and disposal costs is found. Since large companies are facing serious environmental hurdles in the very near future, it is essential that programs are implemented. They currently report no more recycling participation than companies of much smaller sizes. Large companies have more resources to divert into environmental programs. In order to successfully avoid enormous future disposal costs, these resources should be used wisely.

The average yearly waste disposal cost (Table 16) divided by average yearly tonnage disposed (Table 17) yields a current (1991) disposal cost of $155/ton. As recently as 1988, disposal costs were reported at only $40-50/ton (Resource Recycling Systems, 1990), which were considered high at that time. In general, the largest companies pay about five times more for waste disposal than the smallest companies. Note, however, that these averages do have large associated variances. Since landfill space is diminishing, the cost of landfilling will continue to increase dramatically. It is very important to focus on creating breakeven recycling and incineration processes. Strategic locations for transfer stations and facility location near source markets will help. The use of reduction, and reuse will also reduce a company's annual waste disposal quantities. Therefore, the total system of reduce, reuse, recycle and incineration vs. landfilling could help to have enormous impact on future annual disposal costs.

Table 16. Monthly and Yearly Disposal Tonnage and Costs

Q4. In the waste industry, it is common to measure waste by tonnage as well. If possible, please estimate many tons of waste your facility generates per month or year in tons.								
		GROUP (BY SALES)						
RESPONSE:		1	2	3	4	5	6	TOT
1. Tons per month:	MEAN:	.2	.5	1	2.5	7	5.5	2.3
	ST. DEV.:	.5	1	2.3	3.6	3.8	16	8
2. Tons per year:	MEAN:	2.1	14	21	14	103	23	19
	ST. DEV.:	3	49	31	28	152	53	55
GROUP TOTAL		22	26	13	13	6	21	101

Table 17. Average Yearly Disposal Costs

Q5. How much do you pay per year for all solid waste collection and disposal services?								
		GROUP (BY SALES)						
RESPONSE:		1	2	3	4	5	6	TOT
1. Amount per year: (dollars)	MEAN:	2644	932	1555	2601	5852	5918	2939
	ST. DEV.:	8475	1823	1664	3132	6952	11588	6949
GROUP TOTAL		28	37	14	32	8	30	149

Current Waste Stream Volume-In Cubic Yards

Volume analysis was completed by multiplying annual waste quantities by percentages that companies reported for each waste stream category. For volume analysis, statistics accompanied less deviation when comparing companies by size rather than SIC groups. The entire population that responded for volume analysis

was 194 companies. Table 18 reports the average waste stream size at 883 cubic yards of waste per year. For most categories, companies with higher sales generated more waste. By volume, the largest component of waste streams was wood and paper, at 622 cubic yards. The second largest category was "others", which is comprised of glass, food, yard, and all other waste, with a mean of 108 cubic yards. Companies reported that annual plastic waste was the third largest waste stream component, at 106 cubic yards. Metals, which included ferrous and non-ferrous, had the lowest volume reported at 47 cubic yards. These rankings supported results found in 1988 waste stream analysis (U.S. Environmental Protection Agency, 1990). Companies in respective sales groups reported a wide variation in the amount of waste they generated. In part, this is due to the size and location of the market area they serve. Therefore, although the reported waste stream volume illustrates trends similar to those found in literature, the large variation associated with their means reduces their validity.

Table 18. Waste Stream Volume Analysis by Company Size

Q3 and Q6. Please estimate the how much of your waste stream volume is composed of the following materials:								
		GROUP (BY SALES)						
RESPONSE (in yards^3):		1	2	3	4	5	6	TOT
PLASTICS: (PS foam, films and all others).	MEAN:	75	45	156	185	52	121	106
	ST. DEV.:	125	103	284	657	71	245	329
WOOD: (wood, corrugated, office paper and other papers).	MEAN:	285	474	794	554	555	1066	622
	ST. DEV.:	527	1717	1836	872	731	2342	1585
METALS: (ferrous and non-ferrous metals).	MEAN:	19	12	111	16	24	113	47
	ST. DEV.:	62	44	303	35	55	338	193
OTHERS: (glass, food waste and yard waste).	MEAN:	48	27	186	202	37	151	108
	ST. DEV.:	85	50	456	662	58	420	382
MEAN WASTE STREAM PER COMPANY								883
GROUP TOTAL		31	45	22	33	10	36	177

Current Waste Stream Volume-In Percents

The following analysis discusses solid waste streams by percent. The nine SIC groups that had the largest response rate, and therefore the most statistically valid results, were analyzed. Unlike volume analysis, waste stream percentage analysis can obtain valid statistics for SIC groups. The entire responding group for percent analysis was 194 companies.

Figure 2 illustrates waste stream analysis in percentages (not volume) that the top 9 responding SIC groups reported. When comparing retailing, banks, entertainment, education, and membership organizations- retailing, membership, and banking industries had the highest waste disposal of paper and wood products at 88%, 77% and 73% of waste stream composition respectively. For these industries, high wood/paper use for office supplies is common.

Educational institutions had an even proportion of their waste stream represented by paper/wood products (28%), plastics (36%), and "others" (36%). The percentage of metals comprising their waste stream was negligible. Although paper products are common in the education category, plastics and "others" also represent a large part of their waste stream. Plastics are very common for cafeteria use and supplies. "Others", which includes food waste, would also represent a large portion of their waste stream. Entertainment industries reported only 57% of their waste stream as paper/wood products, with an even split around 14% for the remaining categories.

Figure 3 compares the next 4 largest responding SIC groups, construction, manufacturing, non-durable goods wholesalers, and household goods. The largest

portion of the paper/wood waste stream category was reported by the manufacturing industry at 86%. Since paperboard packaging, and pallets would comprise a large portion of waste that is disposed, it is not surprising that plastics, metals, and "others" did not comprise as large a portion of the manufacturing group's waste stream. These combined for the remaining 14% of waste stream composition. This indicates that there is more packaging being disposed of than manufacturing scrap.

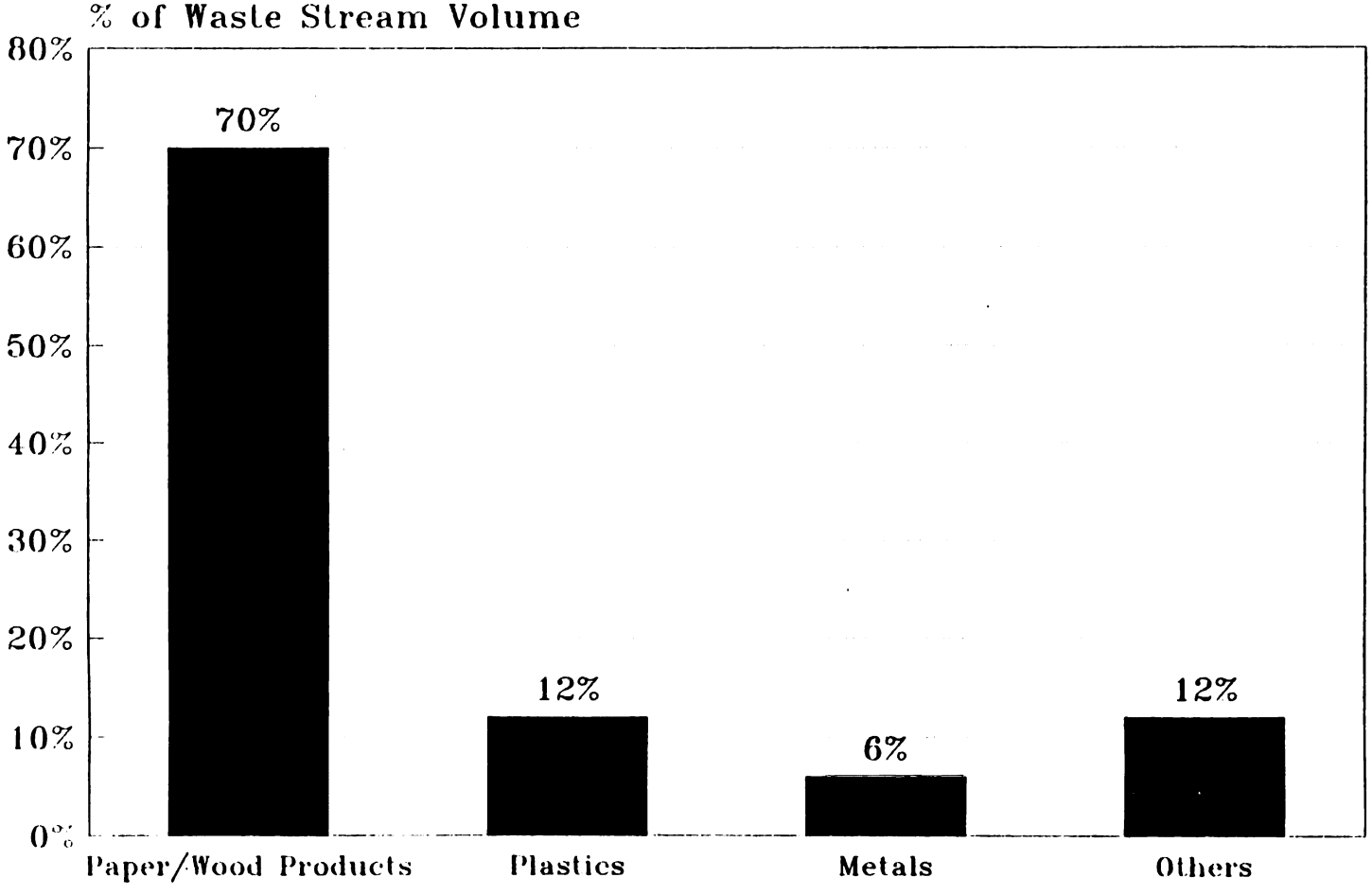
The second largest SIC for the paper/wood category was the construction industry, reporting this as 71% of their waste stream. Projects such as industrial/urban development in the construction industry dispose large quantities of paper/wood products. The construction industry reported 14% of their waste stream as "others", and 12% as plastics.

The two remaining SICs, wholesalers of non-durable goods and household products manufacturers reported 66% and 67% respectively for paper/wood products, with a fairly even split around 11% for the remaining categories. Since wholesalers and household goods manufacturers deal primarily with consumer products (e.g. toothpaste, shampoo, food products, etc.), materials included within "others", plastics, and metals will comprise sizeable portions of their waste streams. Therefore, in addition to paper/wood packaging, these companies dispose large amounts of various packaging materials associated with the products they manufacture.

Figure 1 shows total aggregate waste stream analysis. Paper/wood products were reported as the largest component of the waste stream at 70%. Plastics and "others" represented 12%, and metals 6%. These figures are inconsistent with 1988

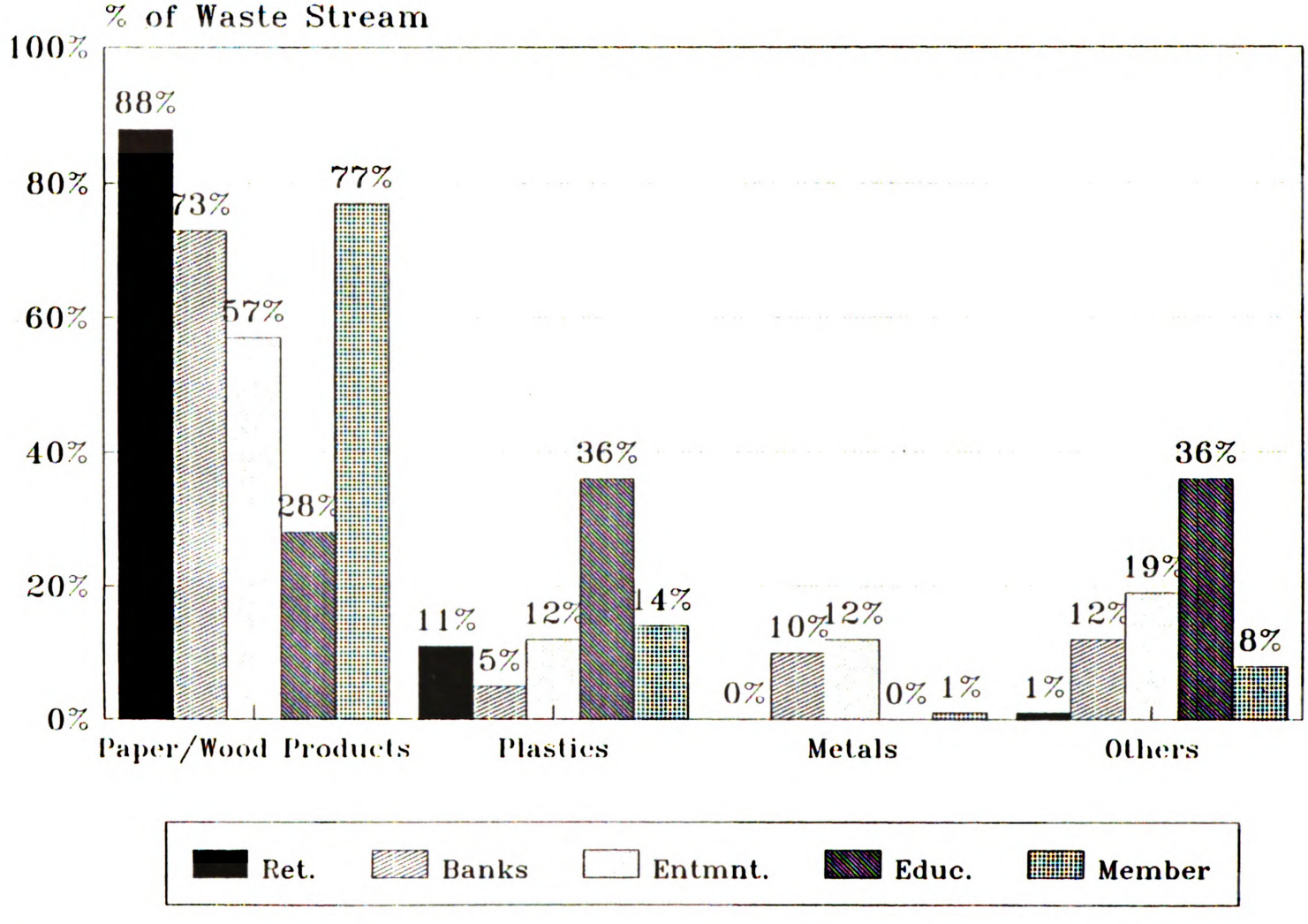
direct waste stream measurement research performed by the EPA. For volumes by percent, the EPA reported paper/wood at 34%, plastics at 20%, "others" at 35%, and metals at 12% (U.S. Environmental Protection Agency, 1990). Although respondents' waste streams are inconsistent with the EPA estimates, respondents' waste streams are for businesses, which represent only a segment of the population. The EPA report was for aggregate waste stream composition, which also included households.

Figure 1. Waste Stream Breakdown
Total of all Respondents



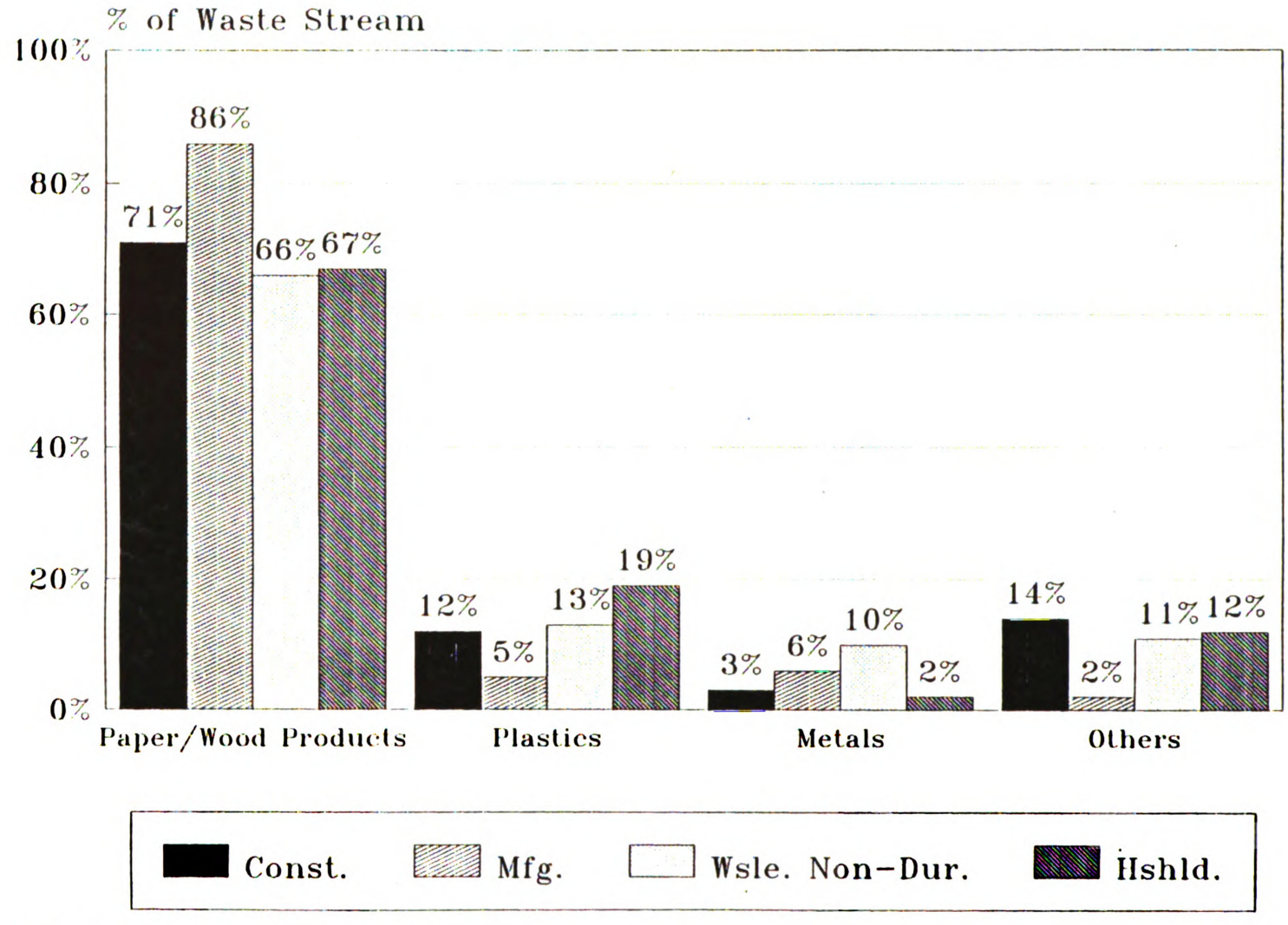
Note: This aggregates all SIC groups.

Figure 2. Waste Streams for 5 SIC groups



Note: Each bar represents one SIC group.

Figure 3. Waste Streams for 4 SIC groups



Note: Each bar represents one SIC group.

Current and Future Recycling Percentages

The EPA reported a 13% rate of material recovery for recycling of total U.S. MSW generation in 1988. In this research, companies said in 1990 they recycled 15% of their waste stream. Table 19 shows that all sales groups reported consistent means around 15%. However, these estimates accompanied large standard deviations. When dividing the current waste stream volume that companies reported they recycle (189 cubic yards) by the mean total waste stream volume they reported (881 cubic yards), this figure increases to just over 21%. However, this type of analysis is less accurate because of the variations associated with both waste stream volume and recycling volume. Table 20 shows that by the year 2000, companies expect recycling efforts to nearly triple, from 15% to 41%. This estimate for the year 2000 had a standard deviation of 14%. The EPA reported that by 1995, recycling should increase to 24%.

The estimated increase in recycling of 26% would reduce waste stream volume from 881 cubic yards to 651 cubic yards, assuming solid waste disposal quantities and company size do not change. If the cost recovering materials for recycling and processing can be made economical, increases in total waste disposal costs may stabilize. However, recycling facilities are expensive to start, and disposal costs will continue to increase until economies of recycling are met. Considering the escalating costs of disposal for landfilling, even without cost effective recycling processes, the reduction in waste stream volume may offset the initial expense of recycling.

Table 19. Current Recycling Estimates (Percentage)

Q7. What percentage (by volume) of your facility's total solid waste stream is recycled?								
		GROUP (BY SALES)						
RESPONSE:		1	2	3	4	5	6	TOT
PERCENT RECYCLED:	MEAN:	14	13	17	15	17	17	15
	ST. DEV.:	24	25	20	28	18	29	25
GROUP TOTAL		30	42	21	35	11	33	172

Table 20. Year 2000 Recycling Estimates (Percentage)

Q26. Currently, approximately 13% of all municipal solid waste is recycled. What percentage of all municipal solid waste do you expect to be recycled by the year 2000?	
RESPONSE OF 180 RESPONDENTS	
MEAN	41%
STANDARD DEVIATION	14%

Current and Future Recycling Volume

Table 21 shows that the volume of materials recycled does not follow trends proportional to the amounts of waste companies generate. For example, by volume, "others" and plastics were close second and third largest waste stream components at 108 and 106 cubic yards respectively. The smallest component was metals at 47 cubic yards. However, for current volume that is recycled, metals were second with 19 cubic yards recycled, "others" third with 9 cubic yards, and plastics were last with only 8 cubic yards recycled per year.

Considering the fact that most plastics are recyclable, this category has room

for considerable increase in recycling since only about 8% of waste stream plastic was reported being recycled. "Others", which includes glass and yard waste, is another category that contains many recyclable and compostable materials. This category also reported only 8% being recycled, and has potential for future increases in recovery for recycling and composting.

The exception to this trend is wood and paper, with a reported mean of 162 cubic yards currently recycled. Wood and paper were the largest component of respondents' waste streams (622 cubic yards), and 162 cubic yards was the largest component by volume recycled. This yields an average of 26% of 622 cubic yards of discarded wood/paper recycled. The EPA reported that in 1988, paper and wood products were also the largest component recycled- with an average of 31% of paper/wood waste generation recycled. However, "others" were second- with an average of 30% of "others" generation recovered for recycling; metals were third- with an average of 25% of metal generation recycled; and plastics were last- with 5% of plastic generation recycled. Respondents' rankings of paper/wood as the largest waste stream component recycled, and plastics as least recycled are two categories that were consistent with the rankings reported by the EPA.

Table 21. Current Recycling Estimates (Volume by Company Size)

Q3 and Q8. Please estimate the how much of your waste stream volume is recycled for each of the following materials:								
CURRENTLY RECYCLED (1991)		GROUP (BY SALES)						
RESPONSE (in yards^3):		1	2	3	4	5	6	TOT
PLASTICS: (PS foam, films and all others).	MEAN:	15	.4	30	4.6	0	4	8
	ST. DEV.:	50	2	119	13	0	16	47
WOOD: (wood, corrugated, office paper and other papers).	MEAN:	25	19	145	91	286	473	162
	ST. DEV.:	79	57	388	315	693	1163	612
METALS: (ferrous and non-ferrous metals).	MEAN:	15	8	30	7	17	39	19
	ST. DEV.:	69	47	85	16	52	199	104
OTHERS: (glass, food waste and yard waste).	MEAN:	21	12	11	2	0	5	9
	ST. DEV.:	85	50	455	662	58	420	382
MEAN TOTAL WASTE STREAM VOLUME RECYCLED								189
GROUP TOTAL		24	37	18	29	9	31	148

Table 22 reports that by the year 2000, respondents tend to agree that more plastics, glass, and yard waste will be recycled or composted. Amounts anticipated to be recycled become more in proportion with the amount of the total waste stream a particular category consumes. For example, in the year 2000 respondents expect that wood and paper products will remain the largest component that is recycled, with an estimate of 433 cubic yards per year recycled. However, plastics will become the second largest category recycled, estimated at 43 cubic yards, and metals and "others" will be a close third and fourth at 30 and 26 cubic yards per year respectively.

The results for volume recycled, currently and in the year 2000, have large standard deviations. This indicates that various companies of the same size provided large differences in their estimates. This may be explained by the fact that all industry groups combined individual sales groups, and by the size of the market individual companies may serve. These figures represent volume that will be recycled in the year 2000 and do not reflect the possibilities of company growth or reduction in size. Therefore, the amounts reflect no changes in the current waste stream size.

By the year 2000, companies expect to recycle 41% of the plastics in their waste stream. This was the largest estimated percentage increase of all categories. This represents a 400% increase over the 8% currently recycled. Metals had the smallest increase at 60%. Since metals represent the smallest waste stream component and are already highly recycled, this will not reduce the waste stream very much.

Although plastics are expected to have largest increase in amounts that will be recycled, the expected increase in recycling from 26% to 70% of paper/wood products will have the largest impact on waste stream reduction. This increase alone could reduce overall waste stream volume by 30%. Plastics recycling will have the second largest impact by reducing waste stream volume an additional 8%. The recycling increases of metals and "others" will combine to reduce waste stream size an additional 2%.

If companies are recycling all four waste stream components by the amounts predicted for the year 2000, overall waste stream volume could be reduced by 40%. Current estimated costs per year for disposal had a mean of $3000. Assuming waste stream size is proportional to disposal costs, savings incurred by reducing waste stream volume could be 40% or $1200 per year. However, this estimate makes an important assumption that recycling processes will become self supporting, and that the costs for recycling will be less than disposal costs. Currently, this is not the case with many recycling programs.

Similar to analysis for waste stream volume, recycling volume was calculated by multiplying the percentages reported per waste stream category by the current volume of that category. Volume analysis variances were smaller when comparing companies by size rather than SIC group.

Table 22. Year 2000 Recycling Estimates (Volume by Company Size)

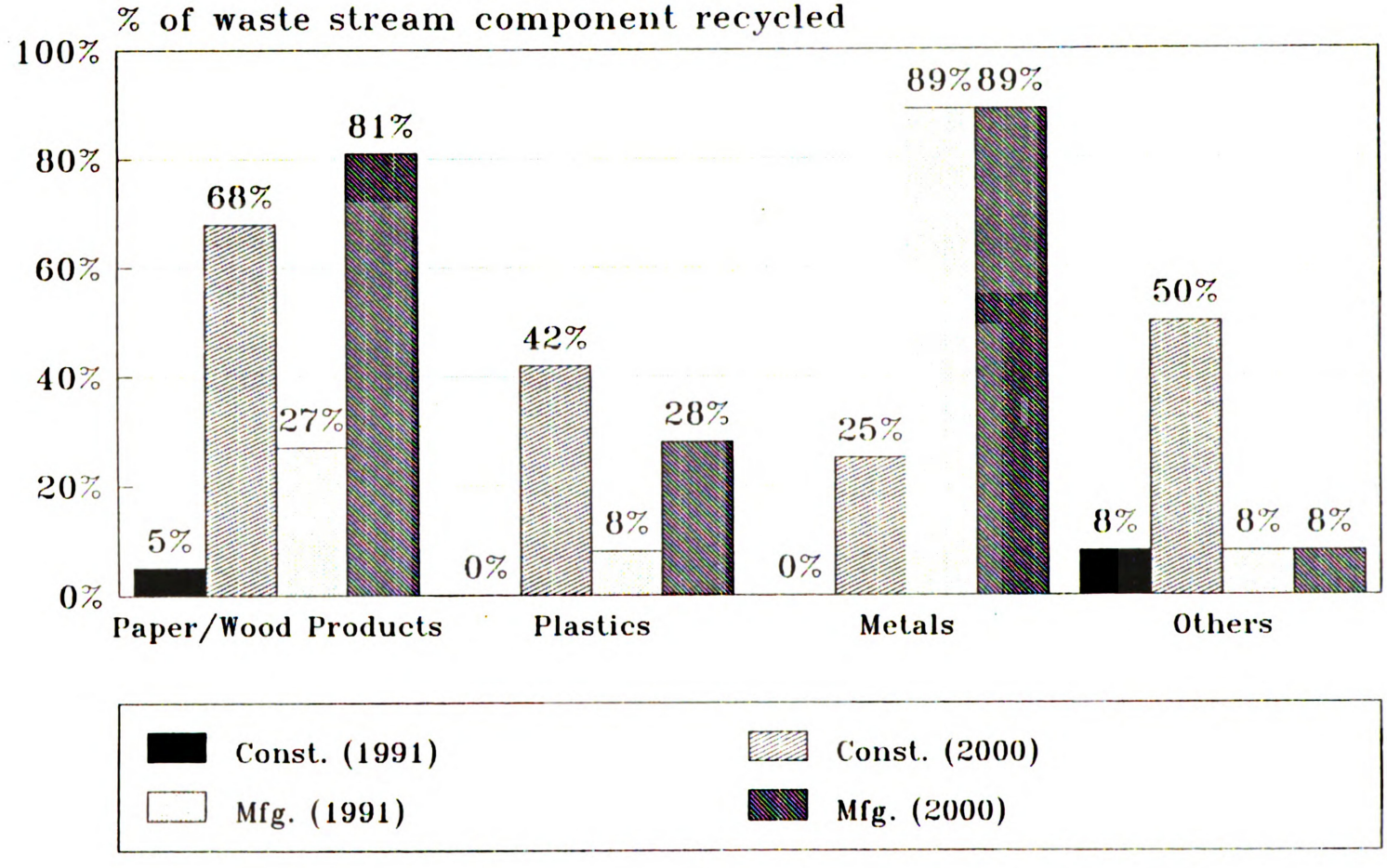
Q3 and Q8 (Part 2). Please estimate the how much of your waste stream volume is expected to be recycled by 2000 for each of the following:								
PROJECTED AMOUNT BY 2000		GROUP (BY SALES)						
RESPONSE (in yards^3):		1	2	3	4	5	6	TOT
PLASTICS: (PS foam, films and all others).	MEAN:	68	15	88	26	0	58	43
	ST. DEV.:	125	43	214	82	0	159	125
WOOD: (wood, corrugated, office paper and other papers).	MEAN:	168	154	640	469	447	795	433
	ST. DEV.:	326	329	1843	1294	1163	1946	1298
METALS: (ferrous and non-ferrous metals).	MEAN:	4	9	50	6	17	84	30
	ST. DEV.:	15	49	168	14	52	243	134
OTHERS: (glass, food waste, yard waste and all others).	MEAN:	14	7	91	19	0	27	26
	ST. DEV.:	44	15	318	46	0	84	126
ANTICIPATED VOLUME RECYCLED IN 2000								506
GROUP TOTAL		20	36	19	27	9	30	141

Figures 4 through 8 illustrate percentage analysis of recycling estimates (i.e. excluding volume and reporting only percentages) for SIC groups. Figure 4 shows substantial recycling increases (about 55%) expected by construction and manufacturing industries for paper/wood. A large percentage of this increase may be attributed to an increase in pallet and paperboard packaging recycling. Similarly,

they also expect large increases in plastics recycling, which again may be linked to plastics used for packaging and the unitization of materials.

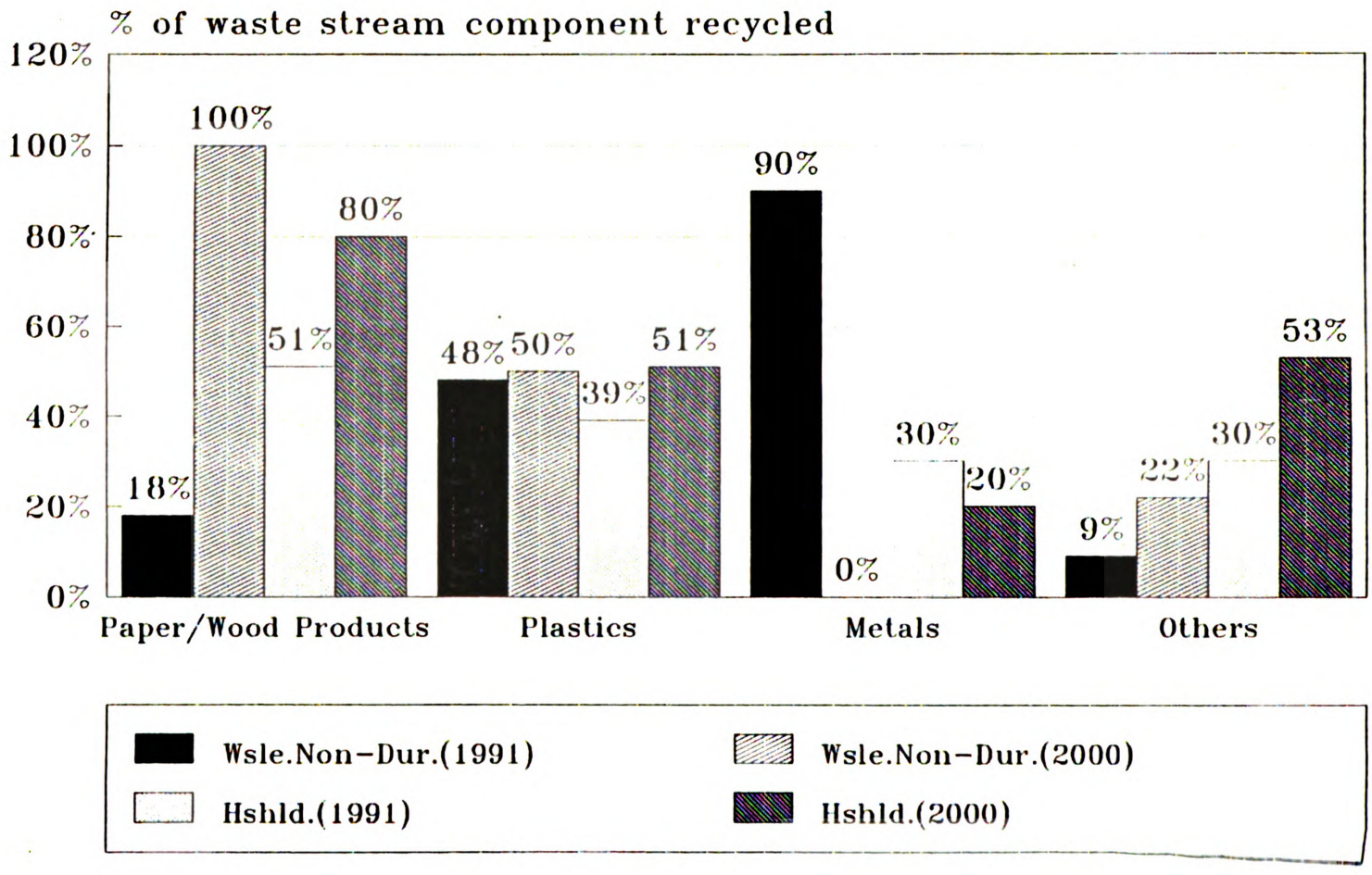
Figure 5 shows large increases expected in wood/paper recycling for wholesalers of non-durable goods (88%), and household goods manufacturers (29%). These industries also have a high utilization of packaging materials in manufacturing and distribution processes, which may be recovered for recycling. In figure 8, membership organizations report an expected 58% increase in paper/wood recycling, which should come from office paper recycling. They also report a 60% increase in plastics recycling, most likely from cups and other plastic food packaging.

Figure 4. Recycling Amounts
For 1991 and 2000



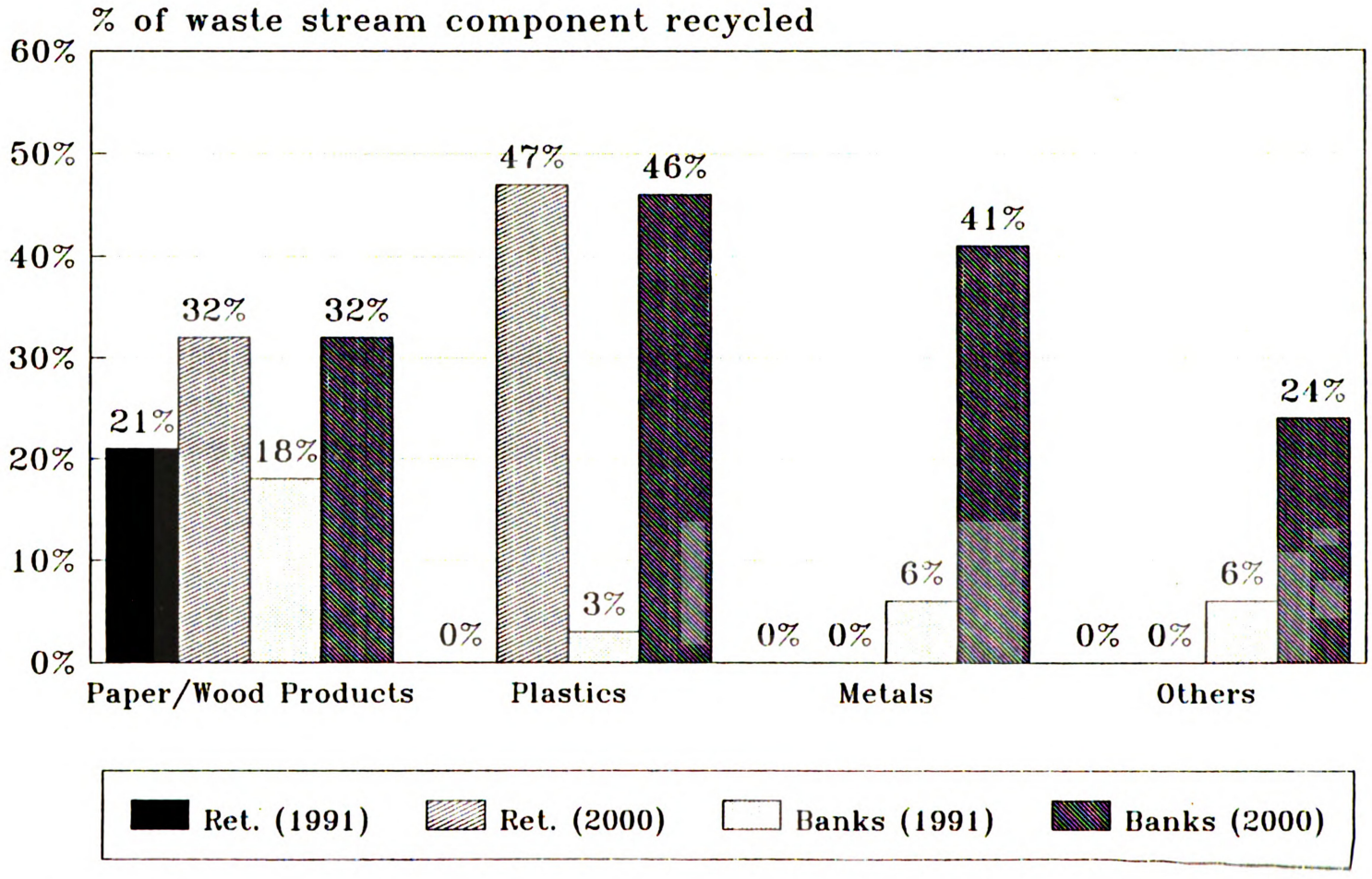
Note: Each set of bars represent one SIC group's data for 1991 and 2000.

Figure 5. Recycling Amounts
For 1991 and 2000



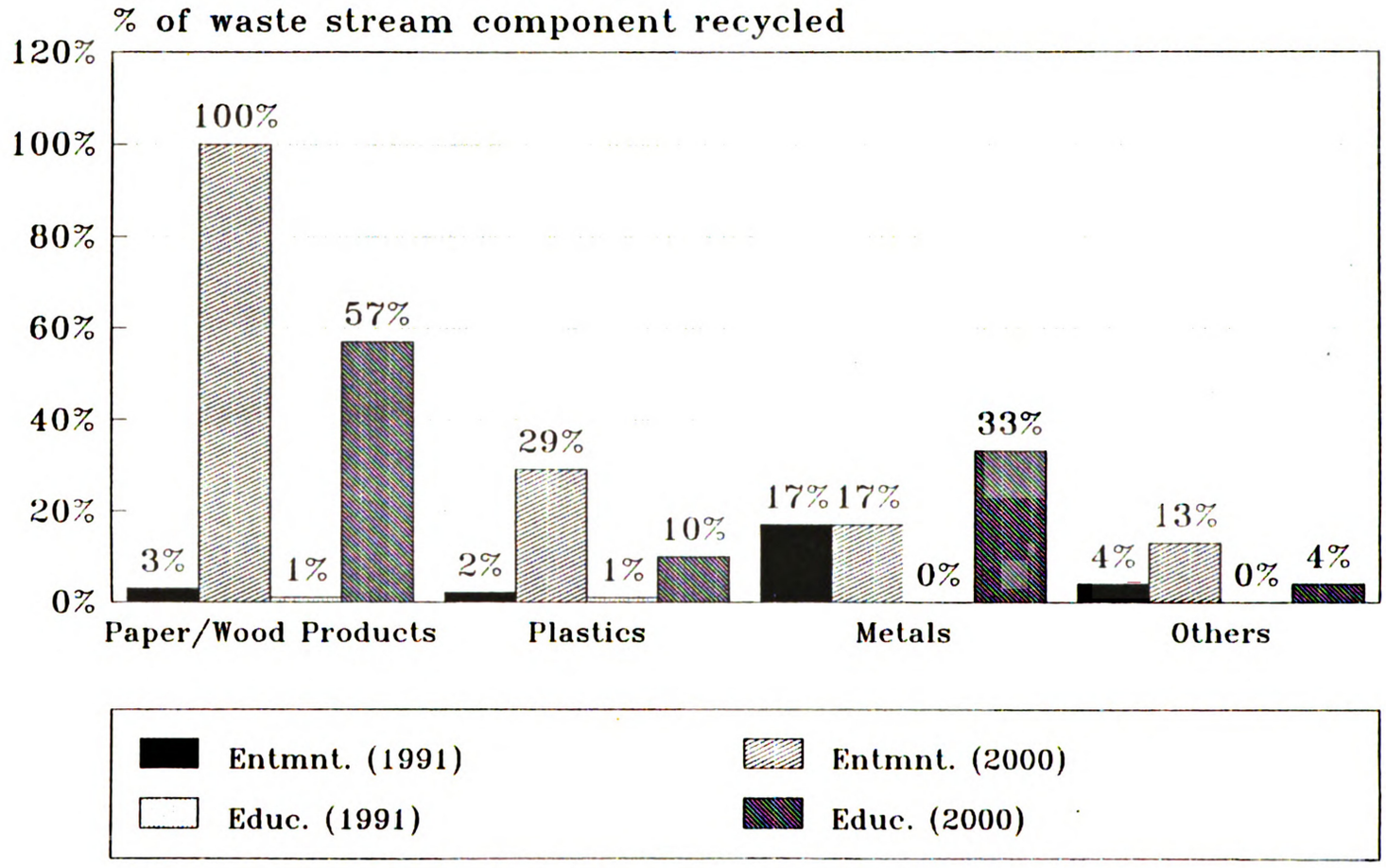
Note: Each set of bars represent one SIC group's data for 1991 and 2000.

Figure 6. Recycling Amounts
For 1991 and 2000



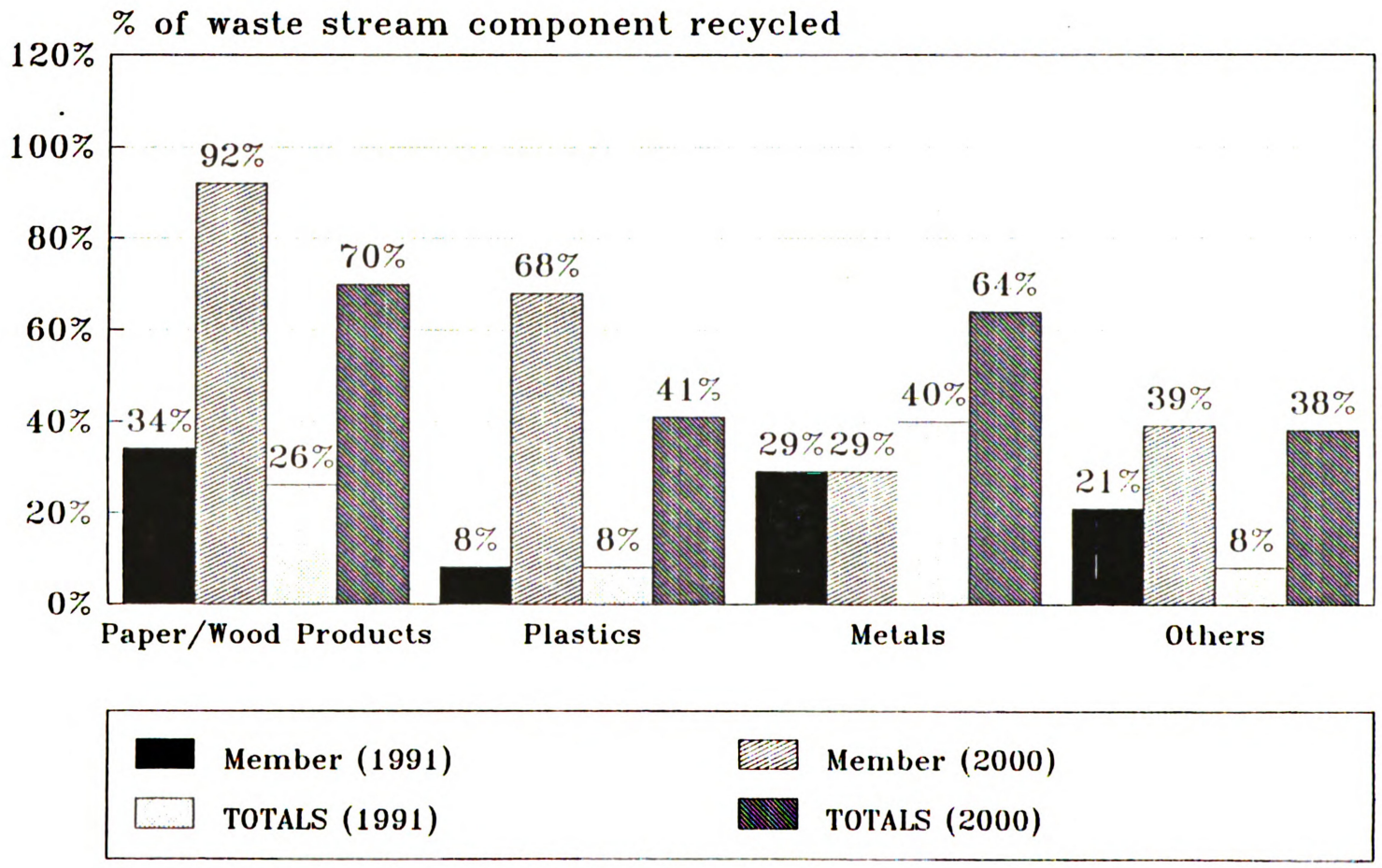
Note: Each set of bars represent one SIC group's data for 1991 and 2000.

Figure 7. Recycling Amounts
For 1991 and 2000



Note: Each set of bars represent one SIC group's data for 1991 and 2000.

Figure 8. Recycling Amounts
For 1991 and 2000



Note: Each set of bars represent one SIC group's data for 1991 and 2000.

PS Foam Related Issues

The following discussion reports survey results from various PS foam related issues. These include uses, associated problems, potential alternatives, seasonality, and predicted future consumption of the material. It will also discuss industry perceptions about issues like separation of PS foam for recycling, incineration of PS foam, and reciprocal recycling agreements.

PS Foam Uses

Table 23 shows that most PS foam is purchased and consumed in food related uses. 30% of food use is PS foam for food service ware, and 5% is for food storage trays. The second largest use is packaging forms to protect products (17%), and packaging fillers such as peanuts (18%); these two combine for 35% of PS foam usage. Overall, these four categories combine for 70% of PS foam use.

Industries that reported high usage of PS foam in these forms include the construction industry (80%), manufacturing industry (40%), household goods manufacturers (53%), retailers (78%), restaurants (64%), and entertainment industries (54%). Therefore, PS foam recyclers should target these facilities, which report a large usage of PS foam in the above mentioned forms, for PS foam recovery.

Table 23. Major Uses for PS Foam

Q9. The following are types of PS foam you may be discarding. What percentage of the total PS foam you discard is comprised of each type?								
		GROUP (BY SALES)						
RESPONSE:		1	2	3	4	5	6	TOT
1. Fire retardant PS foam:	MEAN:	1%	2%	1%	1%	14%	0%	2%
	ST. DEV.:	4%	8%	2%	6%	35%	2%	9%
2. Non fire retardant PS foams:								
A. Packaging forms to protect electronics, mfg. goods or components . .	MEAN:	20%	13%	19%	14%	21%	17%	17%
	ST. DEV.:	33%	25%	33%	26%	27%	27%	28%
B. Packaging filler (e.g. peanuts)	MEAN:	13%	19%	5%	16%	29%	26%	18%
	ST. DEV.:	26%	30%	10%	25%	33%	32%	28%
C. Insulation (refrigeration units, buildings)	MEAN:	5%	10%	7%	1%	7%	2%	5%
	ST. DEV.:	14%	27%	21%	3%	17%	8%	17%
D. Food service (bowls, plates, clamshells, including cafeteria)	MEAN:	24%	29%	40%	28%	36%	30%	30%
	ST. DEV.:	39%	40%	42%	39%	42%	41%	40%
E. Meat, produce or bakery trays . . .	MEAN:	1%	9%	13%	2%	2%	6%	5%
	ST. DEV.:	3%	25%	30%	5%	3%	18%	18%
F. Mfg. scrap .	MEAN:	1%	5%	4%	0%	2%	0%	2%
	ST. DEV.:	2%	22%	12%	0%	3%	0%	12%
TOTAL		33	40	17	29	9	36	178

PS Foam Seasonality Estimates

Companies said they dispose equal amounts of PS foam year round. This provides a base for consistent yearly supply of PS foam to recycling facilities. However, in Table 24, the highest individual percentages of PS foam use were reported for the summer season by Sales Groups 1 and 3. Overall, these estimates are contrary to business cycles and solid waste cycles, which tend to peak in the fall (Watson, 1990).

Table 24. PS Foam Seasonality Consumption Estimates

Q10. Last year, what was the percentage breakdown (by season) of all PS foam you disposed of? ***(Year total = 100%)***								
		GROUP (BY SALES)						
RESPONSE:		1	2	3	4	5	6	TOT
1. Fall	MEAN:	15%	18%	22%	21%	20%	21%	19%
	ST. DEV.:	11%	11%	12%	11%	10%	10%	11%
2. Winter ...	MEAN:	17%	18%	19%	24%	21%	23%	20%
	ST. DEV.:	16%	12%	11%	13%	11%	14%	13%
3. Spring ...	MEAN:	18%	20%	21%	19%	22%	21%	20%
	ST. DEV.:	13%	12%	10%	11%	11%	12%	11%
4. Summer ..	MEAN:	24%	21%	27%	20%	17%	21%	22%
	ST. DEV.:	20%	17%	24%	13%	12%	13%	17%
GROUP TOTAL		29	35	18	25	8	31	146

Problems Associated with PS Foam

The largest problem associated with PS foam is its high volume to weight ratio, which adds sizeable volume to waste containers. This is the largest problem listed in Table 25 for both major use categories. For the cups and food containers category, 14% of the respondents said that additional volume is a problem. For the packaging materials or other PS foam uses category, 20% said additional volume is a problem. Surprisingly, respondents reported that they felt employee and consumer complaints were not much of a problem. Only 5% said they were for cups and food containers, and 4% for packaging materials or other PS foam uses. Overall, estimates for all listed responses were relatively low, indicating no considerable problems associated with PS foam.

Table 25. Potential Problems Associated With PS Foam

Q11. Listed below are two categories of PS foam uses. One is cups and food containers and the other is packaging or other uses you may have for PS foam. Please indicate if your facility is experiencing any of the problems listed for each category.

	CATEGORY (BY FREQUENCY)	
TYPES OF PROBLEMS:	CUPS/FOOD CONTAINERS	PACKAGING MTL/OTHERS
A. Employee complaints	6%	4%
B. Consumer complaints	5%	3.5%
C. Adds sizable volume to disposal containers	14%	20%
D. Collection problems	8%	6%
E. Increased costs for disposal . .	4%	8%
DID NOT ANSWER	50	50
GROUP POPULATION TOTAL	194	194

Potential Alternatives for PS Foam

Most (66%), of the responding group has not considered alternatives. Since companies in general are not facing any problems with PS foam, some are not likely to consider alternatives. This indicates a large percentage of the respondents have material loyalty for PS foam. In addition, Table 26 also shows that 14% reported they have PS foam alternatives in use, and another 20% are considering them. However, within the two largest sales groups (5 and 6) only 6% have switched to alternatives. Regardless, these figures may represent a significant loss in market share for PS foam manufacturers.

Table 26. Percent of Respondents Considering PS Foam Alternatives

Q12. Are you presently considering any alternatives to PS foam?							
	GROUP (BY SALES)						
RESPONSE:	1	2	3	4	5	6	TOT
YES, We already have them in use	30%	9%	6%	27%	0%	6%	14%
YES, We are considering them	17%	15%	22%	15%	20%	31%	20%
NO	53%	76%	72%	58%	80%	63%	66%
GROUP TOTAL	30	34	18	26	10	35	153

If an alternative material for PS foam must be chosen, most respondents say that paper and paperboard materials are the clear favorites for the categories of cups and food containers, and packaging materials (see Table 27). 63% chose paper/paperboard as cups and food container substitutes, and 47% chose paper/paperboard for the packaging materials or others category. Reusable food service tableware was a popular alternative for food containers as well; 32% chose this alternative. Unlike switching to alternative materials, reusable food service tableware does not add to the waste stream. This could eliminate part of the PS foam waste stream and reduce associated disposal costs. Since complaints are rare (Table 25), respondents probably chose reusable tableware based on concerns to reduce their waste stream instead of concerns to increase public relations.

Table 27. Potential Alternatives for PS Foam

Q13. If you discontinued using PS foam, what alternative materials for cups/food containers and packaging materials or other uses would you substitute for it?

	CATEGORY (BY FREQUENCY)	
TYPES OF ALTERNATIVES:	CUPS/FOOD CONTAINERS	PACKAGING MTL/OTHERS
A. Paper or paperboard	63%	47%
B. Reusable food service tableware	32%	NA
C. Other plastics	4%	3%
D. Starch based materials	NA	6%
E. Wood-based materials (i.e. excelsior, sawdust)	NA	12%
DID NOT ANSWER	61	61
GROUP TOTAL	194	194

Types of PS Foam Contamination After Use

Table 28 lists various damage that may occur to PS foam during use. Material changes and damage that may occur to PS foam during use had low estimates. This indicates material integrity exists to a large extent after PS foam use. Therefore, the recyclability of post-industrial PS foam remains high. 15% of the respondents listed food contamination, which increases the cost of recycling by adding an additional rinsing process, as a slight problem for the PS foam cups/food containers category. About 11% listed severe crushing as another type of damage occurring. However, these figures are low, and all other categories of damage had negligible results.

Table 28. Potential PS Foam Contamination After Use

Q14. From the time your facility receives PS foam to the time you dispose of it, do any of the following occur that affect the characteristics of the PS foam?		
	CATEGORY (BY FREQUENCY)	
TYPES OF CONTAMINANTS:	CUPS/FOOD CONTAINERS	PACKAGING MTL/OTHERS
Color change	3%	2%
Food contamination	15%	0%
Severe heat exposure (over 200F)	3%	2%
Severe crushing due to heavy objects, long storage, etc	13%	10%
Chemical contamination	0%	0%
DID NOT ANSWER	60	60
GROUP TOTAL	194	194

Predicted Increases in Future PS Foam Consumption

With little variance, respondents said that they will increase their PS foam consumption by 6% in 1991 and 1994, and 5% in 1996. This signals that PS foam may have strong demand in the future (see Table 29). All sales groups reported roughly the same estimates, indicating that small and large companies alike expect these increases. However, PS foam producers expect only a 2.5% increase in PS foam production for 1992 (C & EN, 1989). In part, this may be due to the loss of market share from companies choosing to switch to alternatives.

Table 29. Predicted Increases in PS Foam Consumption

Q15. PS foam production is expected to increase by about 2.5% next year. Please circle the estimated percentage that your consumption will increase or (decrease) this year, in three years and in five years.								
		GROUP (BY SALES)						
RESPONSE:		1	2	3	4	5	6	TOT
1. This year:	MEAN:	5%	6%	6%	6%	6%	6%	6%
	ST. DEV.:	2%	2%	1%	1%	0%	1%	1%
2. In three years:	MEAN:	6%	6%	5%	5%	6%	6%	6%
	ST. DEV.:	2%	2%	2%	2%	0%	2%	2%
3. In five years:	MEAN:	5%	6%	5%	5%	6%	6%	5%
	ST. DEV.:	2%	2%	3%	2%	0%	2%	2%
GROUP TOTAL		24	28	16	23	9	32	132

Acceptable Costs of Recycling and Transportation Issues

If recycling can be made cost effective, company participation in recycling programs will more than double. Respondents were split on the relevance of costs for recycling; some (30%) said costs would not matter, (see Table 30), which indicates a strong interest in recycling and environmental solutions. However, 28% said that recycling must not exceed current disposal costs. This indicates that many respondents are still concerned with waste disposal and recycling costs. Therefore, it is very important to focus on developing recycling processes that are competitive in cost with landfilling.

Table 30. Necessary Costs of PS Foam Recycling to Induce Participation

Q16. When compared to your current method of disposal, what would the cost of recycling (that your facility will incur) have to be for your facility to recycle PS foam? *(Choose the one that is closest to your firm's attitude)*	
RESPONSE:	TOTAL
1. Recycling cost will not matter . . .	30%
2. Recycling cost could be much greater than disposal cost	6%
3. Recycling cost could be somewhat greater than disposal cost	17%
4. Recycling cost must at least equal to disposal cost	28%
5. Recycling cost must be somewhat less than disposal cost	9%
6. Recycling must be considerably less than disposal cost	10%
GROUP TOTAL	150

Most companies do not transport their own waste. Therefore, they require that waste materials for recycling to be picked up at their facility (Table 31). When transportation costs for PS foam are considered, most (52%) of the respondents said that PS foam must be picked up at their facility. In general, about as many (16%) would be willing to transport PS foam if costs are lower than current disposal costs, as those who would contract for pickup if costs were lower (13%). Therefore, even if personally transporting waste costs less than contracting for pickup, many companies will still not have the means to transport waste and will continue to contract for pickup.

Table 31. PS Foam Recycling Transportation Costs Companies Will Incur

Q17. If a recycling facility for PS foam were available, how much of the transportation costs would you be willing to incur? ***(Choose only one response)***	
RESPONSE:	TOTAL
1. Would transport PS foam if the cost is less than our current cost of disposing PS foam	16%
2. Would not transport PS foam, but would hire someone to transport it if the cost is less than our current cost of disposing PS foam	13%
3. Would not transport PS foam, it must be picked up at our facility	52%
4. Would hire someone to transport PS foam, willing to incur costs up to ___ miles	5%
5. Would transport PS foam, willing to incur costs up to ___ miles	14%
GROUP TOTAL	140

Industry Perceptions and Attitudes About PS Foam

Currently, little non-technical information exists regarding industry perceptions about issues such as separation, incineration, recycling, education, legislation, and other important environmental issues. This section analyzes how companies responded to questions about their perceptions and attitudes regarding these issues.

Since perceptions and attitudes are most useful when viewed by industry, analysis was done by SIC groups. The discussion will present results from particular industry groups, as well as total results for each issue. In addition, complete SIC response breakdowns are available in Appendix B. Since some SIC groups had few companies responding, results are more valid when presented in aggregate. These results analyzed responses from five point Likert scales: 1 represented strongly agree, and 5 strongly disagree. 3 represented a neutral response.

Willingness to Separate Materials for Recycling

Respondents are very confident that employees would be willing to place PS foam into separation bins for recycling. This indicates a strong cooperation in recycling processes expressed by respondents. Most (74%) of the respondents strongly or somewhat agreed, with 49% strongly agreeing, only 11% strongly or somewhat disagreed, and 15% remained neutral. These results are very decisive that respondents feel their employees would be willing to take the time out of their work schedule to separate PS foam for recycling.

Respondents also feel managers will promote separation. Most (80%) strongly or somewhat agreed that management will promote separation, with 52%

strongly agreeing, only 8% strongly or somewhat disagreed. 13% were neutral. As with all decisions, it is important to have managerial support.

Since respondents feel separation will gain strong managerial and employee support, the problem of space availability may be easy to overcome. However, when asked about space availability for separation, companies did express split opinions, 48% strongly or somewhat agreed it was available, and 32% strongly or somewhat disagreed, and 20% remained neutral. Therefore, there is a greater problem associated with floor space availability for separation than with employee and management support.

Manufacturing, wholesalers of non-durable goods, households goods manufacturers, and retailing industries had some of the highest responses in agreement with employee and management willingness for separation. This is important due to the large amounts of their waste that is packaging, and in most cases, recyclable. Manufacturing, households goods manufacturers, and retailing industries also had high responses in agreement with space for separation availability. Wholesalers of non-durable goods reported little space was available for separation.

Compacting of Materials for Recycling at End-user Locations

Compacting materials for recycling at their source makes pickup for recycling more convenient. The idea of purchasing machinery for this purpose received negative responses. Respondents say that added costs for compacting machines to densify material for recycling is not feasible. Most (86%) either strongly or somewhat disagreed they would purchase a densifying machine, and 72% strongly

disagreed. Only 3% strongly or somewhat agreed. Restaurants (17%), and educational institutions (11%) were the only two industries that somewhat agreed they would be willing to purchase a compacting machine. Since many of the waste materials in these industries have large volume/weight ratios (e.g. food PS foam packaging), a compaction machine would be useful to them.

Compactors or densifiers are a recent introduction to the PS foam recycling process. For example, one densifier can compact 8000 eight ounce cups into a cylinder of 15 square inches. However, densifiers do come at a cost (one current model leases for around $300 a month or can be purchased for around $20,000). These machines may be used to compact other recyclable materials as well.

The actual amount of PS foam or other compactable materials respondents are disposing of may be an important consideration. If the amount is low, there is no justification to purchase expensive equipment. Even if the amount is high, respondents do not favor spending a lot of money to support the recycling efforts for only select materials. It will be important that recyclers and manufacturers of these machines provide excellent marketing and educational support of the benefits in purchasing compaction machines.

Attitudes About Incineration

Very few respondents support the idea of incinerating PS foam or other materials. A large number of the respondents, 43%, strongly or somewhat disagreed with incineration. Of these, 29% strongly disagreed. However, a large percentage (43%) were neutral. This indicates that a sizeable number of people may lack

information on the benefits versus the problems associated with incineration. Even though a large number remain neutral, an equally large number are against incineration. Only 3% strongly agreed with incineration, and 12% somewhat agreed. The construction industry agreed most (34% strongly or somewhat) that incineration is a good method of disposal. Manufacturing, retailing and wholesale industries disagreed most with incineration.

Recently, burning PS foam for energy has been getting a lot of attention. Few companies said this is an efficient way to dispose, and the majority contends there are negative concerns. These results indicate a strong interest in methods of waste disposal other than incineration.

Reciprocal PS Foam Recycling Agreements

Although they lack information about reciprocal recycling services, companies do express an interest in services that may help solve waste stream problems. Reciprocal recycling services create markets for materials that have been recycled into useful products. Currently, some recycling companies collect used PS foam, and make useful products such as office supplies such as paper filing trays. Facilities that supply used PS foam pay a fee, and in return they receive the recycled product. When asked to consider this reciprocal service, a large percentage (45%) of the respondents remained neutral.

Since this type of service is new and unfamiliar to many people, respondents probably had difficulty deciding on the issue. However, 36% did strongly or somewhat agree, indicating a strong interest in this type of service, and only 19%

somewhat or strongly disagreed. In addition, companies such as retailers, restaurants, entertainment industries, and membership organizations strongly supported these services. These companies would have many uses for recycled products, especially office supplies.

Industry Perceptions and Attitudes About Solid Waste

The following sections discuss results that respondents reported for issues about solid waste in general. The first two sections discuss solid waste problems within companies, and within the community of southeast Michigan. These are followed by a discussion of reasons to recycle that respondents said were important, and potential inhibitors of industrial recycling.

Solid Waste Problems Within Companies

Respondents were asked about the following solid waste problems at their facility: costs, environmental agencies, and public pressure. They reported that the prevalent problem is cost. 47% of the respondents strongly or somewhat agreed that solid waste costs are a problem, 27% remained neutral, and 26% somewhat or strongly disagreed. In particular, manufacturing companies, wholesalers of non-durable goods, banks, and retailing industries expressed the strongest concern about the cost of solid waste. Since most of these industries dispose large quantities of packaging materials, costs associated with solid waste will be of large concern to them.

External regulatory agencies have been known to pressure companies with

regards to solid waste issues. Respondents were split when environmental pressure from outside agencies was introduced as a potential problem: 37% strongly or somewhat agreed, 30% remained neutral, and 33% strongly or somewhat disagreed. Manufacturing firms and wholesalers of non-durable goods reported the strongest concern about regulatory agencies. Overall, respondents also felt that regulatory agencies were providing more pressure than the public. Most (43%) of the population strongly or somewhat disagreed that public pressure is a problem; of these, 35% strongly disagreed, and the remaining 36% were neutral. Restaurants expressed the largest concern about public pressure. In general, it is clear that public pressure is not a primary catalyst for facilities to solve waste problems. It may seem that the public has provided a lot of pressure for companies to do something about the solid waste issue, but most respondents do not feel their companies are threatened by the public.

Regardless, costs remain a larger concern than both public pressure and regulatory agencies. Concern about costs will probably drive companies to reduce waste streams more than their concern about regulatory agencies and legislation. Pressure from agencies may ease as facilities move to solve waste stream problems because of increasing costs.

Solid Waste Problems Within Communities

When reporting perceptions about community solid waste problems, most (72%) strongly or somewhat agreed solid waste is a problem in their community, and only 10% somewhat or strongly disagreed, with 18% remaining neutral. It is clear

that a very large number of respondents feel their community, which is southeast Michigan (the Metro-Detroit area), faces solid waste problems. Industries that manufacture goods to be sold through stores (i.e. retail, household goods, etc.), and restaurants had the largest concern about solid waste within their community. Given the current recycling efforts of the 10 largest U.S. cities (Watson, 1990), this result is fairly representative of large metropolitan communities.

Primary Reasons for Industrial Recycling

Of eight choices listed as reasons to recycle, respondents said that limited landfill space, groundwater contamination, and increasing costs of solid waste disposal were the most important. Nearly all the respondents (91%), strongly or somewhat agreed that landfill space was a problem. Most (85%) strongly or somewhat agreed that groundwater contamination was a problem, and most (77%) strongly or somewhat agreed that the increasing costs of solid waste disposal is a good reason to recycle.

Respondents said other, less important, reasons to recycle included: Industrial recycling reduces manufacturing costs, public relations, and recycling makes people feel good about themselves. 52% strongly or somewhat agreed that recycling reduces manufacturing costs. 62% strongly or somewhat agreed that public relations is a good reason. 66% strongly or somewhat agreed that it makes people feel good about themselves.

Current legal mandates are of even less concern to the respondents; only 43% strongly or somewhat agreed that mandates are a good reason to recycle. In part,

this may be due to the fact that there are no current legal mandates in the Detroit area.

These results support an important hypothesis. With costs and contamination concerns so high within companies, the push for legislation to force environmental solid waste solutions may not be as important as first believed. It seems that currently, even without strong legal mandates, companies will begin making concerted efforts to recycle their waste streams because of other, more primary reasons.

Although potential legal requirements pose a threat, these may not have to come about to force environmental change. In contrast, the results may be negative as companies may feel they are being forced into certain situations. For example, incineration may be mandated when a company is willing to recycle and feel that recycling is the best solid waste reduction for their facility. If legal mandates are enforced, very careful planning must accompany their implementation as illustrated by the legislation passed in Minnesota (Lodge and Rayport, 1991). Finally, almost all (86%) of the respondents strongly or somewhat disagreed that recycling is not important which shows a positive attitude toward recycling, regardless of the reason.

Primary Inhibitors to Industrial Recycling

Of five reasons listed that may be possible inhibitors to industrial recycling, respondents said that the biggest issue is that consumers lack education. Most (62%) strongly or somewhat agreed consumers lack education, and 20% remained neutral. For recycling or any solid waste reduction program to be successful, education about the program will be very important.

Respondents were split when lack of public participation was introduced as an inhibitor. 34% strongly or somewhat agreed the public will not participate, 40% strongly or somewhat disagreed, and the remaining 26% were neutral. Those in agreement that the public will not participate may be linking public participation to lack of education or socio-economic concerns. For example, people may not know that recycling drop off centers exist in their community. Others may have greater concerns than taking time to recycle. Those disagreeing that lack of participation is an inhibitor probably see a strong concern expressed by the general public with regards to future solid waste management.

Although recycling programs are not inexpensive to implement, respondents did not foresee the costs of recycling or associated complications with recycling as inhibitors. Most (52%) strongly or somewhat disagreed that recycling costs are a problem, with 28% remaining neutral. Also, most (55%) strongly or somewhat disagreed that recycling is too complicated, with 21% neutral. Respondents do have confidence that recycling will become feasible from a cost and technical feasibility viewpoint.

Since these possible inhibitors are important considerations with new recycling programs, companies that overcome educational barriers and promote their programs should be able to develop successful recycling programs. Finally, respondents said that recycling is feasible and that the benefits do outweigh the problems. Nearly all (79%) strongly or somewhat agreed with this statement and another 15% remained neutral. This further supports the notion of the willingness of respondents to support recycling programs in their company and community.

Summary of Results

In general, the larger the company, the larger the waste stream and its associated costs. Limited landfill space will increase future costs for disposal. In addition, since most companies now contract for disposal to landfills, increased transportation costs will also be critical solid waste considerations.

Waste stream breakdowns show wood/paper products to be the largest component, followed by "others" and plastics (very close second and third), and finally, metals. Presently, respondents do not recycle proportional amounts of materials in their waste stream. For example, although plastic is currently the number three waste stream component, it is the least recycled component. However, respondents said that by the year 2000, amounts recycled will be more in proportion with the amount of the waste stream a particular material consumes. At that point, they say that wood/paper will still be the number one component recycled, followed by plastics, others and metals. Plastics are predicted to have the largest increase of all materials that will be recycled. Although plastics will have the largest increase, an increase from 26% to 70% for paper/wood products will have the largest impact on waste stream reduction. Alone, this increase could reduce waste streams 30%. The combined amounts of recycling expected for the other categories could increase this to 40%.

When respondents were asked to predict a specific amount of their waste stream that would be recycled by the year 2000, the mean of this response was 41%. Current literature shows that about 13% of all municipal solid waste is recycled. Respondents said that their companies currently recycle about 15% of their waste

stream. Therefore, respondents expect recycling efforts to nearly triple over the next decade.

When respondents reported their waste stream compositions, no unusual or unexpected results were found. Of all SIC groups, retailing and manufacturing industries reported the largest amount of their waste stream composed of paper/wood at 86% and 88% respectively. These groups contribute large amounts of used logistical packaging (shipping containers and pallets) into the waste stream. For plastics, the second largest waste stream component, education and household products SIC groups reported that it comprised 36% and 19% of their waste stream respectively. These were the two largest SIC groupings for this category. In general, most service providers reported a very large portion of their waste stream as paper/wood products, where the manufacturing sector reported their waste streams as containing more plastics, metals and "others". Although average amounts in cubic yards are available for waste streams and recycling amounts, they had very large standard deviations, and were judged to be unreliable self-reported results.

Most respondents said they currently contract for disposal pick up and that a large portion of their waste stream is landfilled. Therefore, reducing transportation costs and making recycling a breakeven process to increase participation will be important in the near future. This is further supported by the rather large disposal cost incurred by companies for waste disposal that will continue to increase.

Most (70%) of PS foam is used for food service ware, storage trays, packaging filler and packaging forms to protect products. These results provided an industry target for interested recyclers. Respondents said that additional volume to waste

containers was the largest problem associated with PS foam. Employee and consumer complaints were near negligible categories. Most respondents also said that they are currently not considering alternative materials to replace PS foam, but 14% have them in use and 20% are considering them. These figures may represent a substantial market loss for PS foam producers. When asked to choose alternatives, paper and paperboard and reusable food service tableware were the favorites. No sizeable amount of post-use material damage was reported by respondents, except for some crushing due to storage, and food contamination.

Respondents said that they expect to increase the amount of PS foam they currently use by an annual rate of 6%. This is 3.5% higher than reported for PS foam production in the forthcoming year. These results support material loyalty and continued usage in the future by companies choosing not to switch to alternatives. Respondents said that no seasonality exists with their consumption of PS foam, which contradicts business cycles, and indicates strong supply year round for recyclers.

Respondents were very closely split on how much cost of recycling would have to be for them to participate. 30% said cost would not matter, and about 30% said that recycling must at least be as inexpensive as disposal. For transportation of PS foam to recyclers, respondents are no more willing to transport materials to recyclers than they are to transport waste for disposal. This is probably due to lack of transportation vehicles.

Respondents felt that both employees and management would be willing to promote and participate in the separation of materials into bins for recycling. However, there was concern about the availability of space. If considerable

management and employee support exists, this issue may be easy to overcome. Respondents said that paying an additional fee for PS foam compactors was out of the question. This is contradictory to the fact that they said a problem with PS foam is that it adds additional volume to their waste stream. No interest in this type of machine is an indicator of strong concern about costs, and a low volume of PS foam in waste streams.

Very few respondents favored incineration. However, a large percentage of the respondents remained neutral. This may be sign of lack of knowledge about the process. The large number of respondents against incineration indicates that many do not agree with the process. .These results are more conclusive when compared to positive support respondents gave to recycling.

For solid waste issues, respondents said one of the most important reasons to recycle, and the largest problem they are having with solid waste is associated with costs, not government agencies or public pressure. Respondents also decisively agreed that solid waste was a problem in their community. For this survey, the community was Metropolitan Detroit. In addition, decreasing landfill space and groundwater contamination were also very important reasons given to recycle. From this, it was deduced that landfills running out of space and increased costs could lead a motivation to recycle. The move to recycle industrial, commercial, and institutional solid waste may not need as much of a current legislative push as believed. The State of Michigan supports a waste stream reduction program, and the community of southeast Detroit currently has little environmental legislation. Legislation and public relations may not necessarily have to be introduced as catalysts to force

recycling.

Lack of consumer education was listed by respondents as the largest inhibitor for recycling to work. Recycling costs and associated complications were not found to be problems that respondents thought would inhibit recycling. Overall, respondents decisively agreed that the benefits of recycling more than offset the problems associated with it.

Respondents felt their companies were very concerned about costs, landfill space and environmental education. For PS foam, respondents gave positive expectations about its uses and future consumption rates. Materials recycled in the future are expected to increase dramatically for all waste stream categories. In general, respondents said the public, employees and current legislation are not applying a lot of pressure on their companies to participate in waste stream reduction programs. Decreasing landfill space alone may force companies into waste reduction programs without legislation.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Reducing waste, reusing materials, and recycling are becoming popular solid waste solutions for the future due to a number of factors. Environmentally safe waste disposal is no longer simply a "politically correct" consideration that companies choose only for good public relations. Actually, respondents do not feel much pressure coming from the public. Rather, they are more concerned about rising disposal costs, groundwater contamination problems, and are realizing that very soon many landfills will be closed.

Although legislation is sometimes a good method to force policies into action, legal mandates on certain waste disposal methods may not be necessary. Since respondents said increasing costs and limited landfill space are the most important solid waste issues, legislation could be used as more of an incentive than a rule. If legislation to induce participation must be introduced, it may be best to simply increase costs, or reward companies for following environmental policies. For example, the State of Michigan recommends facilities and communities follow the reduce, reuse, recycle hierarchy. They are considering rewarding more environmental funding to those that follow the hierarchy (Michigan Department of Natural Resources, Resource Recovery Section, 1987).

When searching for waste management solutions, companies have many important factors to consider. Most important is environmental education of their employees. This means more than simply placing recycling containers in offices, and hanging banners in manufacturing facilities. It will be necessary to announce and support programs, issue newsletters, put together environmental teams and departments, and continually follow up on a waste management program's progress.

In particular, it is very important that large companies start, monitor, and guide waste management programs to success. On average, large companies reported disposing and paying as much as 5 times more for waste disposal than small companies. Furthermore, small companies pay a higher per ton rate than large companies. These figures will continue to escalate as the cost of waste disposal increases in the future. Therefore, educating employees and promoting waste management programs in companies of all sizes is important.

Recycling and waste management facilities also face very important decisions. Since costs are such a large factor to companies that dispose of waste, recycling facilities will be competing on cost and the number of services they can provide. Efficient pick up routes and scheduling will be essential to keep transportation costs to a minimum. Also, since so many companies report their inability or unwillingness to transport waste for recycling, picking up waste for recycling at its source will remain a necessity. Although the popular choice for disposal is to landfill it, space is running out, and waste management firms that currently pickup waste solely for landfills will be forced to explore pick up for recycling as an additional service.

Recyclers will have to strategically target sources that contain the highest

volume materials, such as paper/wood products and plastics, to overcome operating and high transportation costs. Industries such as construction, manufacturing, retailing, wholesaling, and all service industries reported the highest disposal rates of paper/wood products. Industries such as restaurants, educational institutions, construction, and household goods manufacturers reported high plastic disposal volume. Picking up discarded materials at their source may become convenient, as respondents report their willingness to source separate materials.

Respondents report the largest increase in their recycling efforts will come from plastics recycling. This indicates large sources for plastics recyclers. Recyclers of paper/wood products will see a dramatic increase in the availability of these materials as well. Companies report that the increase in paper recycling alone will amount to a 30% reduction in their waste stream. Strategically recycling facilities and transfer stations to handle this large influx of materials will be critical.

Proposals to implement incineration facilities into communities continue to face opposition. Respondents overwhelmingly report their disapproval of incineration. Education is a very important factor for recycling. If incineration facilities expect approval, education, and promotion will be just as important. The consensus feeling of respondents is that reduce, reuse, and recycle are better near term waste management solutions than incineration.

PS foam attitudes and perceptions were better than the general public may believe. This is good news to PS producers. Companies that do not plan to switch to PS foam alternatives expect increases in consumption over the next five years. However, many companies have considered alternatives (20%), and some already

have them in use (14%). The expected increase in consumption will help offset the loss of PS foam market share. Recyclers will continue to face problems with food contamination, and to a lesser degree, loss of material integrity due to crushing and storage. Compacting the volume of PS foam (and all recyclables) at their source will be an important issue for recyclers.

Companies report that public relations concerns, and employee complaints about PS foam are negligible. They say they will continue to demand more of the material in the future. Again, this is good news to recyclers and PS foam producers.

Costs, environmental education, and awareness will continue to be the most important issues for all waste management solutions. Many respondents express a strong interest in the environment by stating the cost of recycling will not matter. However, if recycling can be made cost effective, participation in programs may double. Recycling and waste management firms will face important pickup and transportation issues to reach breakeven economies. It will be important to target key sources and companies that dispose high volume of waste to minimize their costs. The future success of waste management programs will depend on communication, cooperation, and the willingness of all involved parties to work closely together.

Suggestions for Future Research

Important future recommendations were drawn from this research. To conduct a survey that will analyze companies within specific industries, it is very important to obtain high response rates for statistical validity. Due to low response rates of many SIC groups, it was not possible to analyze waste stream volume by SIC

codes.

It may be difficult for respondents to answer questions about current issues (i.e. incineration, reciprocal recycling programs, etc.). This is supported by the fact that many questions had large "neutral" responses. It is best to provide brief, non-biased background information for each question, and to make surveys as "user friendly" to complete as possible. In addition, statistical analysis is much easier when response choices are closed ended and do not vary widely in nature.

This survey focused on two issues, PS foam and solid waste. It was very important to let respondents know when issues changed. If possible, it is best to focus on a single issue. If this is not possible, it is important to make the transition from topic to topic easy for the respondent and limit the number of topic changes.

To obtain valid quantified analysis of topics like waste stream disposal amounts, recycling rates, and various costs, a survey conducted to only one SIC (industry) would be useful. This would allow detailed analysis of an individual SIC by sales groupings. Therefore, it would be possible to perform analysis of variance (ANOVA), mean separation, and chi-square statistics, to see if differences between groups within a population exist. In addition, regression analysis to view trends would also be useful. These are just a few of the important statistics that could not be performed due to the limitations of the survey. Since this survey was mailed to a large number of SIC groups, small individual SIC response rates prohibited this type of analysis. The survey was also dependent on self reported volume, not direct measurement. This created large variances, and also limited statistical capabilities. SPSS Version 3.1, used in this research for analysis, was capable of completing all

types of recommended analysis mentioned in this thesis.

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APPENDICES

APPENDICES

Appendix A. PS foam and Solid Waste Survey

(COVER PAGE)

POLYSTYRENE FOAM
AND
SOLID WASTE
SURVEY

THE INDUSTRIAL DEVELOPMENT INSTITUTE
MICHIGAN STATE UNIVERSITY, EAST LANSING, MI 48824

Section I - This section of the questionnaire asks about the handling, amount and cost of solid waste at your facility. Solid waste includes all materials that are landfilled, recycled or added back into your manufacturing process. Please fill in or circle the appropriate responses as accurately as possible.

Q1. How does your facility handle solid waste now?

(Circle all that you currently use.)

1. We collect and transport our waste to landfills **1**
2. We collect and transport waste to recyclers **1**
3. We contract with a collection company for disposal to landfills **1**
4. We contract with a collection company for recycling **1**
5. We recycle internally **1**

Q2. Please break down by percentage what happens to your facility's solid waste. If percentages are not available, please give your best estimate:

(Please list percent by volume)

1. Amount of solid waste that reaches landfills ..... ____ %
2. Amount that is incinerated ..... ____ %
3. Amount sold or given to companies for recycling (please specify materials)_____ ..... ____ %
4. Amount that is office paper in recycling programs .... ____ %
5. Amount that is reused in manufacturing (please specify materials) _____ ..... ____ %
6. Other methods, please specify_____ ..... ____ %

Total waste disposed, recycled and reused 100%

Q3. The following are common waste container sizes. In the first column below, please indicate how many waste containers of each of the following sizes are emptied per month at your facility. In the second column, state how full (on average) these containers are when emptied.

	# emptied per month	*Ave. % full*
A. 2 Cubic yard dumpsters	____	____
B. 4 Cubic yard dumpsters	____	____
C. 6 Cubic yard dumpsters	____	____
D. 8 Cubic yard dumpsters	____	____
E. 8 Cubic yard dumpsters w/compactors	____	____
F. 35 Cubic yard roll offs	____	____
G. 35 Cubic yard roll offs w/compactors	____	____
H. 40 Cubic yard roll offs	____	____
I. 40 Cubic yard roll offs w/compactors	____	____
J. 60 Foot semi trailers	____	____
K. Standard plastic garbage bags	____	____
L. Other, please specify_____	____	____
M. Other, please specify_____	____	____

Q4. In the waste industry, it is common to measure waste by tonnage as well. If possible, please estimate many tons of waste your facility generates per month or year in tons. Use fractions if necessary.

_____ tons/month _____ tons/year

Q5. How much do you pay per year for all solid waste collection and disposal services?

$_____/year

Q6. Please estimate the percentage of your waste stream volume that is composed of the following materials.

	% of volume
Plastics	
A. Polystyrene foam	____
B. Plastic film	____
C. Other plastics	____
Wood Products	
D. Wood	____
E. Corrugated (e.g. Cardboard)	____
F. Office Paper	____
G. Other Paper and Paperboard Products	____
Metals	
H. Ferrous (i.e. iron and steel)	____
I. Non-Ferrous (all others)	____
Others	
J. Glass	____
K. Food Waste	____
L. Yard Waste	____
M. Other, please specify _____	____
N. Other, please specify _____	____

Q7. What percentage (by volume) of your facility's <u>total</u> solid waste stream is recycled?

_____percent

Section II - The purpose of this section is to examine the amount of PS foam your facility discards, identify any problems PS foam may be posing, and examine what alternatives could be used.

Q8. You have given an estimate of how much of your waste stream is composed of the following materials. Now, please estimate the percentage of <u>each</u> of these materials that is recycled or composted. In column two, estimate the percentage you expect will be recycled or composted in the year 2000.

	% recycled now	*% recycled in 2000*
Plastics		
A. Polystyrene foam	____	____
B. Plastic film	____	____
C. Other plastics	____	____
Wood Products		
D. Wood	____	____
E. Corrugated (e.g. cardboard).	____	____
F. Office Paper	____	____
G. Other Paper and Paperboard Products	____	____
Metals		
H. Ferrous (i.e. iron and steel)	____	____
I. Non-Ferrous (all others)	____	____
Others		
J. Glass	____	____
K. Food Waste	____	____
L. Yard Waste	____	____
M. Other, please specify _____	____	____
N. Other, please specify _____	____	____

Q9. The following are types of PS foam you may be discarding. What percentage of the total PS foam you discard is comprised of each type?

1. Fire retardant PS foam ..... ____
2. Non-fire retardant PS foams:
   - A. Packaging forms to protect electronics, computers, manufactured goods or components ..... ____
   - B. Packaging filler (e.g. peanuts) ..... ____
   - C. Insulation (e.g. from refrigeration units, buildings) ..... ____
   - D. Food service such as bowls, plates, cups and clamshells (please include your cafeteria) ..... ____
   - E. Meat, produce or bakery trays ..... ____
   - F. Scrap from manufacturing ..... ____
   - G. Other, please specify _____ .. ____

Total percentage of disposed PS 100%

Q10. Last year, what was the percentage breakdown (by season) of all PS foam you disposed of? *(Year total = 100%)*

1. FALL ____ 3. SPRING ____
2. WINTER ____ 4. SUMMER ____

Q11. Listed below are two categories of PS foam uses. One is cups and food containers and the other is packaging or other uses you may have for PS foam. Please indicate if your facility is experiencing any of the problems listed for each category.

(Circle all that apply)

(Types of problems)	Cups/food containers	Packaging mtls/others
A. Employee complaints	1	1
B. Consumer complaints	1	1
C. Adds sizable volume to disposal containers	1	1
D. Collection problems	1	1
E. Increased costs for disposal	1	1
F. Other, please specify _____	1	1
G. No problems	1	1

Q12. Are you presently considering any alternatives to PS foam?

(Circle one)

YES, We already have them in use 1
YES, We are considering them 2
NO 3

Q13. If you discontinued using PS foam, what alternative materials for cups/food containers and packaging materials or other uses would you substitute for it?

(Circle all that apply)

(Alternative materials)	Cups/food containers	Packaging mtls/other
A. Paper or paperboard	1	1
B. Reusable food service tableware	1	
C. Other plastics, specify type _____	1	1
D. Starch-based materials		1
E. Wood-based materials (i.e. excelsior, sawdust)		1
F. Other, please specify _____	1	1

Q14. From the time your facility receives PS foam to the time you dispose of it, do any of the following occur that affect the characteristics of the PS foam?

(Circle all that apply)

	Cups/food Containers	Packaging mtls/others *(Contaminants)*
Color change	1	1
Food contamination	1	1
Severe heat exposure (over 200F)	1	1
Severe crushing due to heavy objects, long storage, etc	1	1
Chemical contamination	1	1
Other, please specify _____	1	1
None	1	1

Q15. PS foam production is expected to increase by about 2.5% next year. Please circle the estimated percentage that your consumption will increase or (decrease) this year, in three years and in five years.

(Percent change)

	(decrease)						increase				
1. This year:	-10	-8	-6	-4	-2	0	2	4	6	8	10
2. In three years:	-10	-8	-6	-4	-2	0	2	4	6	8	10
3. In five years:	-10	-8	-6	-4	-2	0	2	4	6	8	10

Section III - The following questions will ask for your firm's perspective on various issues determining PS foam, solid waste, recycling and future trends in recycling.
Questions 16-21 apply only to PS foam

Q16. When compared to your current method of disposal, what would the cost of recycling (that your facility will incur) have to be for your facility to recycle PS foam?

(Choose the one that is closest to your firm's attitude)

1. Recycling cost will not matter 1
2. Recycling cost could be much greater than disposal cost 1
3. Recycling cost could be somewhat greater than disposal cost 1
4. Recycling cost must at least equal to disposal cost 1
5. Recycling cost must be somewhat less than disposal cost 1
6. Recycling must be considerably less than disposal cost 1

Q17. If a recycling facility for PS foam were available, how much of the transportation costs would you be willing to incur?

(Circle or fill in one response)

1. Would transport PS foam if the cost is less than our current cost of disposing PS foam 1
2. Would not transport PS foam, but would hire someone to transport it if the cost is less than our current cost of disposing PS foam 2
3. Would not transport PS foam, it must be picked up at our facility ... 3
4. Would hire someone to transport PS foam, willing to incur costs up to ____miles
5. Would transport PS foam, willing to incur costs up to _____miles

Listed below are a number of statements. Please indicate the extent that you agree or disagree with each statement.	STRONGLY AGREE		NEUTRAL		STRONGLY DISAGREE
Q18. If separation bins were available.....					
A. Our employees would be willing to separate PS foam	1	2	3	4	5
B. Our facility's management would be willing to promote separation	1	2	3	4	5
C. Our facility has space available for separation bins	1	2	3	4	5
Q19. Compactors or densifiers are a recent introduction to the PS foam recycling process. For example, one densifier can compact 8000 eight ounce cups into a cylinder of 15 square inches. However, the densifier does come at a cost (this model leases for around $300/month or can be purchased for around $20K). Our firm would be willing to pay for this kind of machine.	1	2	3	4	5
Q20. Recently, burning PS foam for energy has been getting a lot of attention. Some say that this is an efficient way to dispose, while others feel that there are pollution concerns. Burning PS foam is a good method of disposal	1	2	3	4	5
Q21. Some companies can collect used PS foam and make office supplies such as paper filing trays. Facilities that supply used PS foam pay a fee and in return they receive the recycled product. We would consider participating in this reciprocal service	1	2	3	4	5

<u>The remaining questions apply to solid waste in general.</u>

Q22. <u>Our facility</u> is facing solid waste problems because of.....					
A. Public Pressure	1	2	3	4	5
B. Costs	1	2	3	4	5
C. Environmental Pressure (agencies, etc.) ...	1	2	3	4	5

Listed below are a number of statements. Please indicate the extent that you agree or disagree with each statement.	STRONGLY AGREE		NEUTRAL		STRONGLY DISAGREE
Q23. Solid waste is a problem in <u>our community</u> . .	**1**	**2**	**3**	**4**	**5**
Q24. To what extent do you agree that each of the following are good reasons for industrial recycling?					
A. Recycled Materials Reduce Manufacturing Costs	**1**	**2**	**3**	**4**	**5**
B. Increasing Cost Of Solid Waste Disposal . .	**1**	**2**	**3**	**4**	**5**
C. Landfills Are Running Out Of Space	**1**	**2**	**3**	**4**	**5**
D. Legal Mandates	**1**	**2**	**3**	**4**	**5**
E. Public Relations	**1**	**2**	**3**	**4**	**5**
F. Makes People Feel Good About Themselves	**1**	**2**	**3**	**4**	**5**
G. Groundwater Contamination	**1**	**2**	**3**	**4**	**5**
H. Recycling Is Not Important	**1**	**2**	**3**	**4**	**5**
Q25. Industrial recycling is not feasible because.....					
A. Recycling Is Too Expensive	**1**	**2**	**3**	**4**	**5**
B. Recycling Is Too Complicated	**1**	**2**	**3**	**4**	**5**
C. Consumers Lack Education	**1**	**2**	**3**	**4**	**5**
D. The Public Will Not Participate	**1**	**2**	**3**	**4**	**5**
E. It Is Feasible; Benefits Of Recycling Do Outweigh The Problems	**1**	**2**	**3**	**4**	**5**

Q26. Currently, approximately 13% of all municipal solid waste is recycled. What percentage of all municipal solid waste do you expect to be recycled by the year 2000?

(Circle one)

0-10%	10-20%	20-30%	30-40%	50-60%	60-70%	70-100%
1	**2**	**3**	**4**	**5**	**6**	**7**

Appendix B. Questions 18-25, Results Reported by Each SIC Group

The following results are complete SIC results for questions 18-25 which were scaled 1 through 5. 1 represents strongly agree and 5 represents strongly disagree. 3 is a neutral response. Each question (or each section of a question) will be accompanied by three tables. These tables will present individual responses by SIC group for that question. It is important to note the response size given in the table. Some SIC groups may not have large response groups. Therefore, statistics may not be as valid for that particular group. The last column of the third table aggregates all of the groups into statistics that represent the entire responding population. The results in the TOTAL column are the results that were covered in the Results and Discussion section.

Q18. If separation bins were available.....

A. Our employees would be willing to separate PS foam.

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	25%	57%		62%	47%
SOMEWHAT AGREE:	25%	20%	67%	30%	24%
NEUTRAL:	25%	17%			24%
SOMEWHAT DISAGREE:	8%	3%	33%	8%	
STRONGLY DISAGREE:	17%	3%			6%
GROUP RESPONSE TOTAL	12	30	3	13	17

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	33%	82%	38%	40%		50%
SOMEWHAT AGREE:	33%		38%	20%		50%
NEUTRAL:	17%	18%	23%	33%		
SOMEWHAT DISAGREE:	17%					
STRONGLY DISAGREE:				7%	100%	
GROUP RESPONSE TOTAL	6	11	13	15	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	22%	33%	67%		67%	49%
SOMEWHAT AGREE:	33%	33%	22%	100%	22%	25%
NEUTRAL:	11%		6%			15%
SOMEWHAT DISAGREE:		17%	6%		11%	5%
STRONGLY DISAGREE:	33%	17%				6%
GROUP RESPONSE TOTAL	9	6	18	1	9	166

Q18. If separation bins were available.....

B. Our facility's management would be willing to promote separation.

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	25%	48%	66%	69%	
SOMEWHAT AGREE:	42%	34%		15%	
NEUTRAL:	17%	10%	33%	15%	
SOMEWHAT DISAGREE:		3%			
STRONGLY DISAGREE:	16%	5%			
GROUP RESPONSE TOTAL	12	29	3	13	16

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	57%	73%	38%	50%		
SOMEWHAT AGREE:	29%	18%	38%	38%	100%	
NEUTRAL:	14%	9%	23%	13%		100%
SOMEWHAT DISAGREE:						100%
STRONGLY DISAGREE:						
GROUP RESPONSE TOTAL	7	11	13	16	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	56%	66%	66%		56%	52%
SOMEWHAT AGREE:			22%	100%	33%	28%
NEUTRAL:	11%	17%			11%	13%
SOMEWHAT DISAGREE:	22%	17%	6%			4%
STRONGLY DISAGREE:	11%		6%			4%
GROUP RESPONSE TOTAL	9	6	18	1	9	166

Q18. If separation bins were available.....

C. Our facility has space available for separation bins.

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	8%	39%			38%
SOMEWHAT AGREE:	8%	29%	33%		13%
NEUTRAL:	25%	11%		8%	25%
SOMEWHAT DISAGREE:	8%	7%	33%	31%	6%
STRONGLY DISAGREE:	51%	14%	33%	51%	18%
GROUP RESPONSE TOTAL	12	28	3	13	16

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	33%	45%	15%	33%		
SOMEWHAT AGREE:	17%	9%	23%	13%	100%	100%
NEUTRAL:	17%	36%	31%	27%		
SOMEWHAT DISAGREE:			15%	13%		
STRONGLY DISAGREE:	33%	8%	16%	14%		
GROUP RESPONSE TOTAL	6	11	13	15	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	11%		22%		33%	28%
SOMEWHAT AGREE:	11%	20%	28%		44%	20%
NEUTRAL:	11%	40%	33%			20%
SOMEWHAT DISAGREE:	11%	20%	6%	100%	11%	11%
STRONGLY DISAGREE:	56%	20%	11%		12%	21%
GROUP RESPONSE TOTAL	9	5	18	1	9	162

Q19. Compactors or densifiers are a recent introduction to the PS foam recycling process. For example, one densifier can compact 8000 eight ounce cups into a cylinder of 15 square inches. However, the densifier does come at a cost (this model leases for around $300/month). Our firm would be willing to pay for this kind of machine.

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:					
SOMEWHAT AGREE:					
NEUTRAL:	10%	11%		8%	25%
SOMEWHAT DISAGREE:		14%		8%	13%
STRONGLY DISAGREE:	90%	75%		84%	62%
GROUP RESPONSE TOTAL	10	28	3	12	16

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:			8%			
SOMEWHAT AGREE:	17%		8%			
NEUTRAL:		18%	8%	13%		
SOMEWHAT DISAGREE:	17%		23%	19%		50%
STRONGLY DISAGREE:	66%	82%	53%	68%	100%	50%
GROUP RESPONSE TOTAL	6	11	13	16	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:			6%			1%
SOMEWHAT AGREE:	11%					2%
NEUTRAL:	11%	20%			11%	11%
SOMEWHAT DISAGREE:	22%	20%	11%		22%	14%
STRONGLY DISAGREE:	56%	60%	83%	100%	67%	72%
GROUP RESPONSE TOTAL	9	5	18	1	9	160

Q20. Recently, burning PS foam for energy has been getting a lot of attention. Some say that this is an efficient way to dispose, while others feel that there are pollution concerns. Burning PS foam is a good method of disposal.

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	17%	4%			
SOMEWHAT AGREE:	17%	7%		8%	19%
NEUTRAL:	8%	36%	33%	58%	38%
SOMEWHAT DISAGREE:		11%	33%	17%	6%
STRONGLY DISAGREE:	58%	43%	33%	17%	38%
GROUP RESPONSE TOTAL	12	28	3	12	16

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:				13%		
SOMEWHAT AGREE:	17%	10%	8%	6%		
NEUTRAL:	17%	80%	33%	63%	100%	50%
SOMEWHAT DISAGREE:	50%		42%	13%		
STRONGLY DISAGREE:	17%	10%	17%	6%		50%
GROUP RESPONSE TOTAL	6	0	12	16	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:						3%
SOMEWHAT AGREE:	22%		17%		22%	12%
NEUTRAL:	33%	33%	44%	100%	56%	43%
SOMEWHAT DISAGREE:	44%		6%			14%
STRONGLY DISAGREE:		66%	33%		22%	29%
GROUP RESPONSE TOTAL	9	6	18	1	9	161

Q21. Some companies can collect used PS foam and make office supplies such as paper filing trays. Facilities that supply used PS foam pay a fee and in return they receive the recycled product. We would be consider participating in this reciprocal service.

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	36%	7%		8%	13%
SOMEWHAT AGREE:	9%	4%		33%	19%
NEUTRAL:	45%	74%	33%	33%	50%
SOMEWHAT DISAGREE:		15%	66%	8%	6%
STRONGLY DISAGREE:	9%			17%	13%
GROUP RESPONSE TOTAL	11	27	3	12	16

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	17%	18%	9%	19%		
SOMEWHAT AGREE:	50%	36%	45%	13%	100%	100%
NEUTRAL:	33%	27%	36%	56%		
SOMEWHAT DISAGREE:						
STRONGLY DISAGREE:		22%	9%	13%		
GROUP RESPONSE TOTAL	6	11	17	16	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	33%		11%		11%	14%
SOMEWHAT AGREE:	11%	40%	28%		22%	22%
NEUTRAL:	44%	20%	22%	100%	33%	45%
SOMEWHAT DISAGREE:	11%		17%		11%	8%
STRONGLY DISAGREE:		40%	22%		22%	11%
GROUP RESPONSE TOTAL	9	5	18	1	9	158

Q22. Our facility is facing solid waste problems because of...

A. Public pressure:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	11%	4%		8%	
SOMEWHAT AGREE:	11%	4%	33%	17%	15%
NEUTRAL:	44%	54%		25%	46%
SOMEWHAT DISAGREE:		4%	33%	8%	
STRONGLY DISAGREE:	33%	36%	33%	42%	38%
GROUP RESPONSE TOTAL	9	28	3	12	13

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	29%	8%		7%		
SOMEWHAT AGREE:	14%	17%	23%	21%		
NEUTRAL:	14%	33%	31%	29%	100%	50%
SOMEWHAT DISAGREE:	14%	17%	15%	7%		50%
STRONGLY DISAGREE:	29%	25%	31%	36%		
GROUP RESPONSE TOTAL	7	12	13	14	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	17%	33%	6%			7%
SOMEWHAT AGREE:	17%	33%	12%		14%	14%
NEUTRAL:	33%	33%	24%	100%	29%	36%
SOMEWHAT DISAGREE:	17%		6%			8%
STRONGLY DISAGREE:	17%		53%			35%
GROUP RESPONSE TOTAL	6	3	17	1	7	148

Q22. Our facility is facing solid waste problems because of...

B. Costs:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	55%	21%	33%	25%	33%
SOMEWHAT AGREE:	9%	18%	33%	17%	7%
NEUTRAL:	27%	32%		8%	40%
SOMEWHAT DISAGREE:		4%		25%	
STRONGLY DISAGREE:	9%	25%	33%	25%	20%
GROUP RESPONSE TOTAL	11	28	3	12	15

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	17%	25%	33%	14%	100%	
SOMEWHAT AGREE:	33%	25%	20%	29%		
NEUTRAL:	17%	33%	33%	36%		50%
SOMEWHAT DISAGREE:			7%			50%
STRONGLY DISAGREE:	33%	17%	7%	21%		
GROUP RESPONSE TOTAL	6	12	15	14	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	13%		17%		25%	25%
SOMEWHAT AGREE:	63%	100%	11%		25%	22%
NEUTRAL:	13%		22%	100%	25%	27%
SOMEWHAT DISAGREE:	13%		6%			5%
STRONGLY DISAGREE:			44%		25%	21%
GROUP RESPONSE TOTAL	8	3	18	1	8	157

Q22. Our facility is facing solid waste problems because of...

C. Environmental pressure (agencies, etc.):

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	30%	38%		15%	12%
SOMEWHAT AGREE:		16%	67%	15%	29%
NEUTRAL:	30%	39%		23%	29%
SOMEWHAT DISAGREE:	10%	3%			
STRONGLY DISAGREE:	33%	16%	33%	46%	29%
GROUP RESPONSE TOTAL	10	31	3	13	17

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	33%	17%		12%		
SOMEWHAT AGREE:			38%	29%	100%	
NEUTRAL:	17%	50%	31%	41%		50%
SOMEWHAT DISAGREE:	17%	8%	8%			
STRONGLY DISAGREE:	33%	25%	23%	18%		50%
GROUP RESPONSE TOTAL	6	12	13	17	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:		33%	6%		11%	15%
SOMEWHAT AGREE:	17%	67%	28%	100%	11%	22%
NEUTRAL:			17%		22%	31%
SOMEWHAT DISAGREE:	17%		6%		11%	5%
STRONGLY DISAGREE:	17%		44%		44%	28%
GROUP RESPONSE TOTAL	6	3	18	1	9	162

Q23. Solid waste is a problem in our community.

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	45%	56%	33%	25%	44%
SOMEWHAT AGREE:	18%	22%	33%	42%	28%
NEUTRAL:	27%	9%	33%	25%	28%
SOMEWHAT DISAGREE:		3%		8%	
STRONGLY DISAGREE:	9%	9%			
GROUP RESPONSE TOTAL	11	32	3	12	18

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	71%	25%	47%	38%		50%
SOMEWHAT AGREE:	14%	42%	20%	33%	100%	
NEUTRAL:	14%	33%	33%	10%		50%
SOMEWHAT DISAGREE:				5%		
STRONGLY DISAGREE:				14%		
GROUP RESPONSE TOTAL	7	12	15	21	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	25%	40%	32%		44%	42%
SOMEWHAT AGREE:	50%	60%	32%	100%	22%	30%
NEUTRAL:	13%		16%		11%	19%
SOMEWHAT DISAGREE:			11%			3%
STRONGLY DISAGREE:	13%		11%		22%	7%
GROUP RESPONSE TOTAL	8	5	19	1	9	176

Q24. To what extent do you agree that each of the following are good reasons for industrial recycling?

A. Recycled materials reduce manufacturing costs:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	9%	21%	33%	15%	29%
SOMEWHAT AGREE:	36%	30%	33%	54%	18%
NEUTRAL:	36%	27%	33%	31%	47%
SOMEWHAT DISAGREE:	9%	18%			6%
STRONGLY DISAGREE:	9%	3%			
GROUP RESPONSE TOTAL	11	33	3	13	17

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	14%	8%	21%	48%		
SOMEWHAT AGREE:	29%	33%	57%	10%		
NEUTRAL:	29%	33%	7%	24%	100%	100%
SOMEWHAT DISAGREE:	29%	25%	14%	14%		
STRONGLY DISAGREE:				5%		
GROUP RESPONSE TOTAL	7	12	14	21	1	1

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	13%	40%	32%		22%	24%
SOMEWHAT AGREE:	63%	40%	26%		22%	28%
NEUTRAL:	13%	20%	26%		22%	28%
SOMEWHAT DISAGREE:			11%		11%	12%
STRONGLY DISAGREE:	13%		5%			3%
GROUP RESPONSE TOTAL	8	5	19	1	9	175

Q24. To what extent do you agree that each of the following are good reasons for industrial recycling?

B. Increasing cost of solid waste disposal:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	58%	35%	66%	36%	37%
SOMEWHAT AGREE:	17%	32%	33%	50%	26%
NEUTRAL:	8%	24%		7%	21%
SOMEWHAT DISAGREE:	8%	6%		7%	
STRONGLY DISAGREE:	8%	3%			16%
GROUP RESPONSE TOTAL	12	34	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	86%	42%	29%	53%		
SOMEWHAT AGREE:	14%	42%	57%	11%	100%	100%
NEUTRAL:		16%	14%	32%		
SOMEWHAT DISAGREE:						
STRONGLY DISAGREE:				4%		
GROUP RESPONSE TOTAL	7	12	14	19	1	1

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	25%	40%	53%		56%	43%
SOMEWHAT AGREE:	50%	40%	32%	100%	33%	34%
NEUTRAL:	13%	20%	5%		11%	16%
SOMEWHAT DISAGREE:						2%
STRONGLY DISAGREE:	13%		11%			5%
GROUP RESPONSE TOTAL	8	5	19	1	9	178

Q24. To what extent do you agree that each of the following are good reasons for industrial recycling?

C. Landfills are running out of space:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	77%	67%	66%	57%	63%
SOMEWHAT AGREE:	23%	22%	33%	21%	21%
NEUTRAL:		3%		7%	11%
SOMEWHAT DISAGREE:		3%		14%	
STRONGLY DISAGREE:		6%			5%
GROUP RESPONSE TOTAL	13	36	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	100%	58%	57%	71%		100%
SOMEWHAT AGREE:		25%	36%	24%	100%	
NEUTRAL:		8%	7%			
SOMEWHAT DISAGREE:						
STRONGLY DISAGREE:				5%		
GROUP RESPONSE TOTAL	7	12	14	21	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	88%	66%	68%	100%	89%	69%
SOMEWHAT AGREE:	12%	33%	21%			23%
NEUTRAL:						3%
SOMEWHAT DISAGREE:			5%		11%	3%
STRONGLY DISAGREE:			5%			2%
GROUP RESPONSE TOTAL	8	6	19	1	9	185

Q24. To what extent do you agree that each of the following are good reasons for industrial recycling?

D. Legal mandates:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	31%	21%	33%	7%	5%
SOMEWHAT AGREE:	8%	24%	33%	36%	42%
NEUTRAL:	38%	42%	33%	57%	42%
SOMEWHAT DISAGREE:	15%	3%			5%
STRONGLY DISAGREE:	8%	9%			5%
GROUP RESPONSE TOTAL	13	33	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	29%	17%	14%	17%		
SOMEWHAT AGREE:	14%	8%	14%	17%		
NEUTRAL:	57%	67%	57%	33%	100%	100%
SOMEWHAT DISAGREE:		8%	7%	11%		
STRONGLY DISAGREE:			7%	22%		
GROUP RESPONSE TOTAL	7	12	14	18	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	13%	17%	29%		22%	18%
SOMEWHAT AGREE:	50%	33%	24%	100%	44%	25%
NEUTRAL:	37%	17%	24%			41%
SOMEWHAT DISAGREE:		17%	24%		11%	8%
STRONGLY DISAGREE:					22%	7%
GROUP RESPONSE TOTAL	8	6	17	1	9	177

Q24. To what extent do you agree that each of the following are good reasons for industrial recycling?

E. Public relations:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	38%	30%	33%	21%	21%
SOMEWHAT AGREE:	8%	33%	33%	57%	47%
NEUTRAL:	38%	27%	33%	21%	26%
SOMEWHAT DISAGREE:	15%				
STRONGLY DISAGREE:		9%			5%
GROUP RESPONSE TOTAL	13	33	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	43%	42%	43%	26%		50%
SOMEWHAT AGREE:	14%	12%	36%	16%		
NEUTRAL:	43%	42%	21%	37%	100%	50%
SOMEWHAT DISAGREE:				5%		
STRONGLY DISAGREE:				16%		
GROUP RESPONSE TOTAL	7	12	14	19	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	38%	66%	33%		22%	32%
SOMEWHAT AGREE:	38%	17%	17%		56%	30%
NEUTRAL:	13%	17%	39%	100%		30%
SOMEWHAT DISAGREE:	13%		6%			3%
STRONGLY DISAGREE:			6%		22%	6%
GROUP RESPONSE TOTAL	8	6	18	1	9	179

Q24. To what extent do you agree that each of the following are good reasons for industrial recycling?

F. Makes people feel good about themselves:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	25%	33%		29%	32%
SOMEWHAT AGREE:	25%	30%	66%	50%	32%
NEUTRAL:	17%	33%	33%	14%	37%
SOMEWHAT DISAGREE:	17%				
STRONGLY DISAGREE:	16%	3%		7%	
GROUP RESPONSE TOTAL	12	33	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	57%	42%	43%	40%		
SOMEWHAT AGREE:	14%	33%	21%	20%	100%	100%
NEUTRAL:	14%	25%	29%	30%		
SOMEWHAT DISAGREE:			7%	5%		
STRONGLY DISAGREE:	13%			5%		
GROUP RESPONSE TOTAL	7	12	14	20	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	38%	66%	33%		44%	36%
SOMEWHAT AGREE:	50%	33%	22%		11%	30%
NEUTRAL:			33%		33%	26%
SOMEWHAT DISAGREE:	13%		7%	100%		3%
STRONGLY DISAGREE:			5%			5%
GROUP RESPONSE TOTAL	8	6	18	1	9	179

Q24. To what extent do you agree that each of the following are good reasons for industrial recycling?

G. Groundwater contamination:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	66%	66%	66%	50%	63%
SOMEWHAT AGREE:	17%	20%	33%	36%	16%
NEUTRAL:	16%	11%			21%
SOMEWHAT DISAGREE:		3%			
STRONGLY DISAGREE:				14%	
GROUP RESPONSE TOTAL	12	35	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	86%	66%	43%	55%	100%	50%
SOMEWHAT AGREE:	14%	25%	50%	20%		
NEUTRAL:		9%	7%	10%		50%
SOMEWHAT DISAGREE:						
STRONGLY DISAGREE:				15%		
GROUP RESPONSE TOTAL	7	12	14	20	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	63%	33%	56%		78%	60%
SOMEWHAT AGREE:	37%	50%	22%	100%	12%	25%
NEUTRAL:			17%			10%
SOMEWHAT DISAGREE:		12%	6%			2%
STRONGLY DISAGREE:						3%
GROUP RESPONSE TOTAL	8	6	18	1	9	181

Q24. To what extent do you agree that each of the following are good reasons for industrial recycling?

H. Recycling is not important:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:		6%			5%
SOMEWHAT AGREE:		3%			
NEUTRAL:	17%	3%			16%
SOMEWHAT DISAGREE:	8%	19%	33%	14%	16%
STRONGLY DISAGREE:	75%	69%	66%	86%	63%
GROUP RESPONSE TOTAL	12	32	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:		17%		5%		
SOMEWHAT AGREE:			7%			
NEUTRAL:				14%		
SOMEWHAT DISAGREE:	14%	17%	14%	24%	100%	
STRONGLY DISAGREE:	86%	66%	79%	57%		100%
GROUP RESPONSE TOTAL	7	12	14	21	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:						5%
SOMEWHAT AGREE:	13%					2%
NEUTRAL:		17%	6%			6%
SOMEWHAT DISAGREE:			11%	100%	22%	16%
STRONGLY DISAGREE:	87%	83%	83%		78%	71%
GROUP RESPONSE TOTAL	8	6	18	1	9	179

Q25. Industrial recycling is not feasible because....

A. Recycling is too expensive:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	8%	6%			16%
SOMEWHAT AGREE:	15%	12%		7%	5%
NEUTRAL:	31%	32%		29%	37%
SOMEWHAT DISAGREE:	15%	26%	100%	29%	11%
STRONGLY DISAGREE:	31%	24%		36%	31%
GROUP RESPONSE TOTAL	13	34	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:			14%	5%		
SOMEWHAT AGREE:	14%	8%	21%	20%	100%	
NEUTRAL:	14%	42%	36%	10%		50%
SOMEWHAT DISAGREE:	29%	25%	7%	25%		50%
STRONGLY DISAGREE:	42%	25%	21%	40%		
GROUP RESPONSE TOTAL	7	12	14	20	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	13%				11%	6%
SOMEWHAT AGREE:		40%	29%			14%
NEUTRAL:	38%		18%	100%	33%	28%
SOMEWHAT DISAGREE:	25%	40%	29%		22%	24%
STRONGLY DISAGREE:		20%			33%	28%
GROUP RESPONSE TOTAL	8	5	17	1		179

Q25. Industrial recycling is not feasible because....
B. Recycling is too complicated:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	15%	3%			11%
SOMEWHAT AGREE:	15%	23%		21%	16%
NEUTRAL:	23%	29%		14%	32%
SOMEWHAT DISAGREE:	15%	14%	100%	21%	11%
STRONGLY DISAGREE:	31%	31%		43%	32%
GROUP RESPONSE TOTAL	13	35	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:			7%	5%		
SOMEWHAT AGREE:	14%	8%	14%	25%		
NEUTRAL:	14%	42%	28%	10%	100%	50%
SOMEWHAT DISAGREE:	29%	25%	14%	20%		50%
STRONGLY DISAGREE:	43%	25%	36%	40%		
GROUP RESPONSE TOTAL	7	12	14	20	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:					11%	4%
SOMEWHAT AGREE:	25%	20%	18%	100%	11%	19%
NEUTRAL:	13%		12%		11%	21%
SOMEWHAT DISAGREE:	25%	60%	41%		33%	23%
STRONGLY DISAGREE:	38%	20%	29%		33%	32%
GROUP RESPONSE TOTAL	8	5	17	1	9	180

Q25. Industrial recycling is not feasible because....
C. Consumers lack education:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	38%	44%	33%	21%	37%
SOMEWHAT AGREE:	8%	21%	33%	7%	37%
NEUTRAL:	31%	15%	33%	36%	21%
SOMEWHAT DISAGREE:	8%	12%		14%	5%
STRONGLY DISAGREE:	15%	9%		21%	
GROUP RESPONSE TOTAL	13	34	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	42%	25%	7%	29%		
SOMEWHAT AGREE:	29%	25%	57%	38%	100%	100%
NEUTRAL:	29%	8%	21%	19%		
SOMEWHAT DISAGREE:		25%	7%			
STRONGLY DISAGREE:		17%	7%	14%		
GROUP RESPONSE TOTAL	7	12	14	21	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	38%		24%		33%	30%
SOMEWHAT AGREE:	38%	66%	29%	100%	33%	32%
NEUTRAL:	13%		12%			20%
SOMEWHAT DISAGREE:		17%	24%		11%	10%
STRONGLY DISAGREE:	13%	17%	12%		23%	8%
GROUP RESPONSE TOTAL	8	6	17	1	9	181

Q25. Industrial recycling is not feasible because....

D. The public will not participate:

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	15%	24%		7%	11%
SOMEWHAT AGREE:	8%	21%	33%	14%	32%
NEUTRAL:	31%	32%		21%	32%
SOMEWHAT DISAGREE:	38%	15%	66%	28%	21%
STRONGLY DISAGREE:	8%	8%		28%	4%
GROUP RESPONSE TOTAL	13	34	3	14	19

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:		17%		15%		50%
SOMEWHAT AGREE:	14%		43%	25%	100%	
NEUTRAL:		25%	21%	25%		50%
SOMEWHAT DISAGREE:	57%	25%	14%	5%		
STRONGLY DISAGREE:	29%	33%	22%	30%		
GROUP RESPONSE TOTAL	7	12	14	20	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:			6%			11%
SOMEWHAT AGREE:	38%	33%	12%		56%	23%
NEUTRAL:	25%	17%	41%		11%	26%
SOMEWHAT DISAGREE:	25%	33%	29%	100%	11%	23%
STRONGLY DISAGREE:	12%	16%	12%		22%	17%
GROUP RESPONSE TOTAL	8	6	17	1	9	180

Q25. Industrial recycling is not feasible because....

E. It is feasible; the benefits of recycling outweigh the problems.

	GROUP (BY SIC)				
RESPONSE:	Const.	Mfg.	Whsle. Dur.	Whsle. Non-dur.	Hshld.
STRONGLY AGREE:	46%	49%		36%	56%
SOMEWHAT AGREE:	38%	34%	100%	50%	11%
NEUTRAL:	15%	11%		14%	33%
SOMEWHAT DISAGREE:		3%			
STRONGLY DISAGREE:		2%			
GROUP RESPONSE TOTAL	13	35	3	14	18

	GROUP (BY SIC)					
RESPONSE:	Rest.	Ret.	Banks	Entmnt.	Health	Legal
STRONGLY AGREE:	86%	42%	36%	48%		
SOMEWHAT AGREE:	14%	25%	50%	14%	100%	50%
NEUTRAL:		17%	7%	29%		50%
SOMEWHAT DISAGREE:		8%	7%			
STRONGLY DISAGREE:		8%		9%		
GROUP RESPONSE TOTAL	7	12	14	21	1	2

RESPONSE:	Educ.	Social Service	Member	Public Safety	Others	TOTAL
STRONGLY AGREE:	63%	33%	39%		56%	46%
SOMEWHAT AGREE:	13%	50%	39%	100%	33%	33%
NEUTRAL:	24%		5%		11%	15%
SOMEWHAT DISAGREE:		12%	17%			4%
STRONGLY DISAGREE:						2%
GROUP RESPONSE TOTAL	8	6	18	1	9	182