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Electronics Reuse and Recycling Project

Massachusetts Department of Environmental Protection

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INTRODUCTION

The Massachusetts 1999 Jobs Through Recycling (JTR) grant has provided invaluable assistance to recycling businesses, which, in turn, have spurred the growth of recycling markets for used electronic equipment. Within Massachusetts alone, the JTR grant led directly to the development of two new CRT recycling companies, the expansion of a third, and the addition of CRTs and used electronics to the list of items accepted by several traditional recycling collectors. The market development stimulated through the JTR grant not only allowed DEP to plan on a reliable infrastructure for the upcoming Waste Ban on CRTs, but also created jobs.

While the Massachusetts DEP, working for EPA, was the lead organization for this project, a team of researchers and consultants completed most of the work. Each of these experts offered unique contributions, most of which are attached in Attachments to this report.

The JTR final report provides a comprehensive summary of specific accomplishments and lessons learned during the course of the grant. More detail is contained in the Attachments. The greatest value of all, however, was the actual experience of collecting, analyzing, and marketing over 20,000 CRT containing electronic devices from a population of 1,350,000 residents. Without the consulting, exploration and recording funded by this project, Massachusetts would not have been able to learn so much from, and capitalize upon, these collection pilots.

In the year 2000, the Massachusetts Electronics recycling program will be expanded again, to include over 100 municipalities and 3.5 million residents. This coverage would not have been possible without the savings achieved through the JTR research.

A. Background and Overview

Background: Used electronics are a fast-growing percentage of the municipal solid waste stream. This percentage is expected to grow over the next decade, due to several factors:

- declining average useful life of personal computers
- approaching retirement of a "baby boom" generation
- changes from analogue to digital, high-definition television and audio standards

On the contrary, MADEP believes it is important to "shake-down" an electronics infrastructure now, before the supply of electronics increases dramatically over the next 5-10 years. The US Telecommunications Act of 1996 may be delayed, but the triumph of digital over analogue transmissions is inevitable. The electronics disposal problem will get worse if no plan is put into place to recycle these items now.

The lack of an electronics-recycling infrastructure, and the high reported costs of recycling programs held to date (Hennepin County, MN; Union County, NJ; etc.) make this challenge more intimidating to solid waste officials. However, Massachusetts DEP has experience in establishing new recycling infrastructures, such as those for white goods, tires, curbside recycling, and plastic recycling. The lessons learned from those programs are important to undertaking infrastructure development for used electronics.

In 1989, Massachusetts Department of Environmental Protection (MADEP) banned "White Goods" (refrigerators, washers, dryers, etc.) from disposal at solid waste facilities. One year later, tires were banned. Plastic containers were added to the list of waste ban items in 1994.

While recycling of these items is commonplace today, each item was considered a market pariah at the time it was banned. White goods with PCB capacitors had led to the shutdown of several scrap metal shredders in 1989. Tires were considered completely unrecyclable. Plastic recycling cost as much as $900 per ton in 1993.

Today, the white goods ban is enforced almost universally. Almost any service station will take used tires for a small fee. Most residents pay those fees without thinking twice. Access to curbside recycling (which cost three times the cost of trash recycling in 1990) has grown from zero to seventy percent of the Massachusetts population; tip fees are now 1/3 of trash tip fees. And after a rough start, plastic recyclables are among the most valuable commodities.

Given this experience, Massachusetts DEP has chosen not to be intimidated by initial high costs of CRT and electronics recycling programs. Instead, the state has adopted a 5-point plan to establish an electronics-recycling infrastructure (Attachment 1):

1. Remove HW disincentives to CRT handling
2. Research and Develop CRT recycling markets
3. Establish a statewide contract for electronics recycling
4. Establish a municipal grant program using permanent regional facilities
5. Ban CRTs from Disposal: 1/1/00

For more information, go to www.state.ma.us/dep/recycle.

The April 1, 2000, waste ban on television and computer monitor CRT disposal will drive the collection of electronics for recycling, assuring recycling investors a steady supply of material. It will also demand an infrastructure for CRT collection to handle that material.

Meanwhile, in the short term, municipalities require some kind of market certainty in order to undertake infrastructure development. Just as curbside recycling must be built around a materials recovery facility, and a MRF is built on a solid paper market, this chain is as strong as the weakest link. A comprehensive electronics infrastructure must be built around a solid CRT market.

Currently, most TVs and computers are either disposed of with solid waste in municipal packer trucks, or are collected separately for disposal with bulky wastes (furniture, mattresses, heavy appliances, etc.). Haulers consider these items dangerous to their drivers, who must pick up the bulky items and place them under hydraulic compactor blades. This means, in all likelihood, that the effect of a waste ban will be swift and immediate. Haulers immediately began leaving white goods, tires and auto batteries at the curb a decade ago, because they were easily identified separate from the trash, and because they had no incentive to handle them if they did not need to.

Alternative methods of handling need to be developed before the waste ban takes place. To identify the least costly collection program, *we looked at every place where used TVs and computers are already professionally handled.* Which of these methods makes markets for electronics more accessible, more competitive, and more affordable? If TVs and monitors are risky for trash collectors to handle, who has demonstrated the experience and willingness to handle them?

- Some communities have established special curbside pick-ups for large "bulky" appliances like white goods, in part to divert those items from solid waste disposal. Some of these communities are already taking TVs in these bulky curbside collections.

- Some communities have established temporary drop-off programs for electronics recycling, (e.g. Somerville) often during a special household hazardous waste drop-off day.

- The average TV / monitor repair shop receives hundreds of abandoned CRTs from residents who don't want to pay the price of repair. Many also regularly shop at Thrift Stores, or examine abandoned TV/monitors, to see whether they can be repaired or used for parts. These repairers are experts in safe CRT handling and repair.

- Donating the unwanted appliance to charity is widespread – often in the misplaced hope that the charity will undertake the parts and labor to repair the appliance. Schools are also recipients of "wishful donors". These non-profits do indeed have uses for these items, but often lack software or technical expertise to make them useful.

- Commercial computer recycling has prospered in Massachusetts. A study by the University of Massachusetts showed 48 firms recycling or refurbishing computers from Massachusetts's generators. The scope of these recycling operations varies widely, from "chop shops" seeking specific parts to resellers to precious metals recyclers.

- Moving companies are often present with a truck at the time a decision not to keep a TV is made.

Given these alternatives to CRT and electronics collections, which method will yield the best markets? The most vendors? The most reuse? Which collection method will create the most jobs? The goal of this project is to match the type of collection program with the type of market which will yield the greatest benefit to the environment and the biggest benefit to job creation.

Overview

The purpose of this JTR project was to fulfill point #2 of the 5-point plan: to research and develop end markets for residentially disposed TV's, computer monitors, and associated devices (cpu, printer, VCRs, etc). The development of an environmentally sound and cost effective infrastructure for end-of-life electronic equipment will be vital to the success of point #5, the waste ban.

While collection methods were not the focus of the grant, the ways that materials are collected can have a profound impact on the accessibility and cost of different recycling markets. Just as markets for commingled containers differ from markets for segregated glass, plastic, aluminum and tin, the collection methods for used electronics have a profound impact on the bidding pool. This JTR report evaluates the marketing implications of different handling and collection strategies.

The initial evaluation of markets was based on previous surveys of 48 commercial electronics recyclers, and new surveys of 176 (of 326) television repair shops, 4 white goods appliance collectors, 10 Charity/Re-Use/Thrift facilities, 2 retailers, 20 computer monitor repair shops, and 32 electronics exporters. Moving companies were not contacted directly but have been approached by one of the charities. Our basic goal was to talk to anyone who handles other people's used TVs or computers on a daily basis.

To make surveys and site visits more effective, the research was performed concurrently with actual municipal electronics recycling programs. MADEP provided free recycling of CRT items collected in bulk, initially through a county drop-off program, and later to a broad array of residential collection methods. The first of these collections were held through one-day drop-off programs (like those in previous Somerville, MA, and Binghamton, NY, pilots) at 3 sites in Franklin County Massachusetts. A curbside bulky program was established in Springfield 2 months later. Collections through 2 Western Massachusetts charities soon followed.

The material collected in Franklin County and other rural Western Massachusetts programs was processed through the University of Massachusetts, Amherst, (UMass) Office of Waste Management. UMass in turn performed de-manufacturing time studies on computers and "brown goods" (TVs, VCRs, stereos, etc.), sampled brands, and held two competitive bids for recycling both electronic devices and their components. The materials collected at other programs (charities, Springfield curbside) were compared visually to the material processed at UMass, just as the collection processes themselves were compared.

The success of the municipal pilot programs – and the charity collection model in particular – led to early expansion of the program in other areas of the state. In the winter and spring, municipal collections were expanded to include several urban areas, including Springfield, Boston, Saugus, and Pittsfield. Unlike the rural programs, these collections were not limited to one-day programs.

Several models were evaluated on a large-scale basis. These fall into three types of handling program:

- temporary or outdoor drop-off point (recycling center, charity, school, retailer)
- door-to-door (curbside bulky waste programs, charity door-to-door collections)
- permanent collection centers (charities, repair shops, retailers, municipality)

The basic finding of these comparisons was that spreading the collections out over time allowed the handlers to try more markets. The longer the material could be analyzed, kept dry, and reviewed by a permanent staff person, the more potential markets could be realized. Storing it over time is only effective, however, in a controlled, attended environment. A vendor, picking up all the material, can of course hold this same advantage. But the more sorted the material, the more vendors the collector has to choose from.

In particular, repair and reuse (both domestic and export) were shown to be very important markets. These vendors are specialized and cannot typically handle all of the electronic material. The demanufacturing program at UMass showed that the recyclers scrap prices were fair when the labor to demanufacture is accounted for. However, the 5-10% of material, which can be resold or repaired, can be more than ten times as valuable as the remaining scrap.

While many of the collection programs are difficult to strictly classify (Umass was both permanent regional facility processing drop-off material, Salvation Army held curbside collections as well as attended Permanent Centers), the following gives an overview of how collection programs capitalized on the reuse potential described above.

Temporary Drop-Offs: This market dynamic explains the limitations of temporary drop-offs, one vendor makes where the choice to resell, export or repair in a short time frame. Typically, too much material is handled in too short a time to allow even for "plug and play" (the most basic screening, to see whether an appliance already works when you turn it on). However, bringing in a third party expert (e.g. a TV repair technician) can allow many of the most valuable items to be screened for resale, repair and parts. The longer the period of time the "temporary" drop-off is open, the more potential repair and resale markets have to succeed.

Drop-Offs:

Convenient in rural areas, where amounts are not worth separating.

110,000 residents, 53 tons after diversion (<5%)

Door-to-Door Collections: This collection scheme resulted in less marketable material, but much higher diversion rates than the other programs. MADEP promoted this program where it was "turn-key" (i.e. the items were already being collected separately at the curb). Reuse and repair markets were limited, though diversion was high and avoided disposal costs were therefore considerable. Where charities (like Salvation Army in Saugus) added non-working electronics to their door-to-door programs, however, these programs failed. The charity performed far too much work for a non-working appliance, and enjoyed none of the municipalities' avoided disposal benefits.

Door-to-Door Collection:

Most convenient, with high diversion rates. Material could not be efficiently separated for reuse.

150,000 residents, 91 tons after diversion (<5%)

Permanent Collection Centers: The charities were able to spend more time with material, to sort it into more categories, and to maximize the value. Other private vendors can offer the same type of "triage" for value (resale, repair, parts salvage and scrap), though no single vendor yet has the network of Goodwill or Salvation Army. Most vendors have expertise in a specific area (e.g. export, scrap processing, TV repair). Apple computer, PC, and television experts rarely excelled in the same field. Inviting those vendors to take from the charities seemed to work the best.

Permanent Collection Centers:

Established collection and handling. Material was efficiently separated or reused.

1,320,000 residents, 289 tons after est. 35% diversion.

The study benefited from the handling experience and resale infrastructure of Charities like Salvation Army and Goodwill Industries. In many cases, these charities were able to offer access to thousands of households on a daily or weekly basis. However, these facilities must be guaranteed free recycling of the electronics they cannot recycle. A limit on software licensing was a serious disincentive to resale of PCs through their thrift shops. More incentives should also be offered for these facilities to cherry-pick items whose resale value may not compensate the sorting labor or extended category storage space.

Employment Implications of the various markets: As for employment, the job value of scrap electronics recycling was shown to be much higher than landfill and incineration, as previous value-added studies would suggest. However, the relative job creation of repair and resale markets was even higher, more decentralized, and more local to points of collection. Recycling scrap electronics supports ten times more jobs than land filling; grading them for parts and resale generates over 100 times more jobs than scrap recycling. Even export, which was expected to yield low job creation (domestically – obviously there would be high repair job creation overseas), proved to provide as many or more jobs than recycling. This was attributed to the high requirements of inspection, sorting, and preparation for different overseas purchasing specifications.

The report ultimately recommends prioritizing collections that can maximize the resale and repair job markets. Maximizing recovery through existing charities, repair shops, and other permanent centers should be the first step. Afterwards, capturing more material via bulky goods collections will be necessary to get material out of the urban waste stream. Drop-off programs may be most appropriate in rural areas; one-day drop-off programs may be used to attract charities or private repairers.

In this way, the resale value of items is used to support the collection infrastructure, and is not lost in the vast quantity of material delivered to a central processing plant. For example, if charities set aside SVGA and VGA monitors, VCRs, and 19+ inch televisions, repair/resale experts can formally "cherry pick" those items without adding the capacity to process the other 80% of material.

A central processing contract, like Massachusetts has for CRT recycling, can remove the risk of speculative storage when a state sets up a large number of new collection sites. Such a contract can be funded either through residential drop-off fees, state recycling budgets, or special taxes. While a great deal of international discussion has been given to "product stewardship", bottle bills and European take-back programs show that bottlers/OEMs contract collections out to such a third party. (The bill-payer/sponsor has the greatest degree of control over the third party processor).

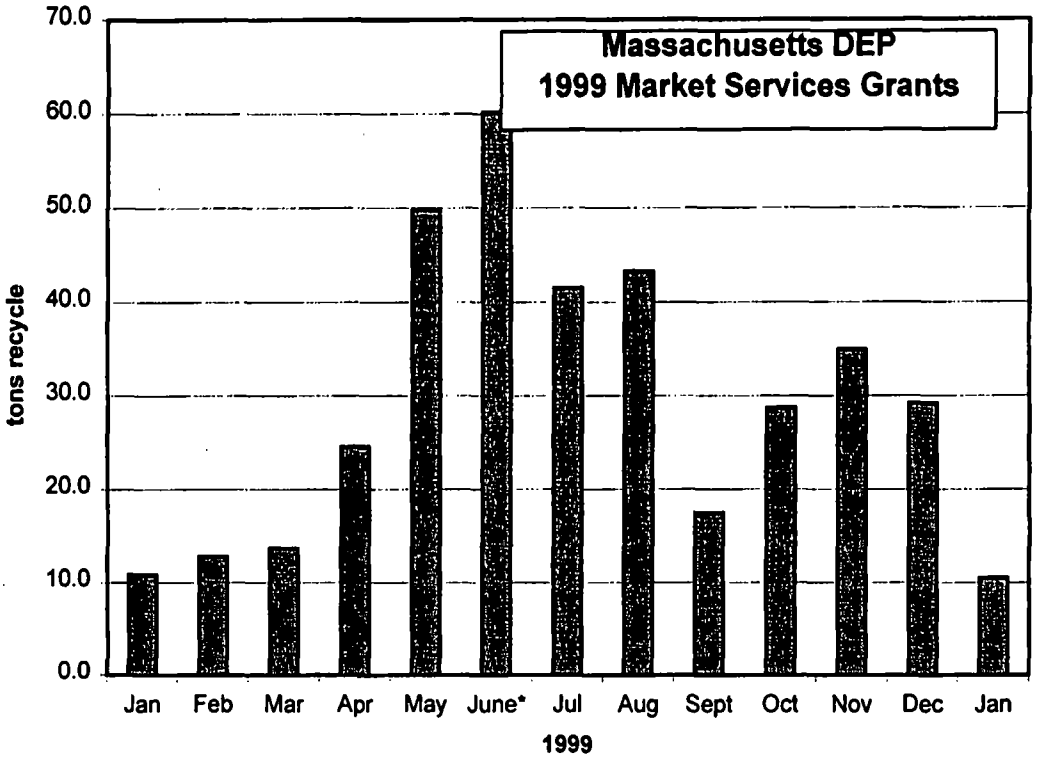
Product stewardship is an important topic for the future recyclability, repairability and resells ability of procured materials. Through the strength of government procurement, or voluntary "blue book" guidelines, or legislation, the future marketability of electronics should be supported by

- On-line repair/product manuals of ALL past and present durable electronics
- primary or secondary ("spare tire") software licenses (transferable with the machine)
- recycled content and/or non-toxic content guidelines

Finally, it is important to have a regulatory driver which stimulates collection but which does not threaten the charities and small third party handlers.

Table 1

TONS OF CRTs RECYCLED PER MONTH - 1999



This chart shows the collection of television and computer equipment in 1999. All collections were paid for through a central state contract issued by the Massachusetts Department of Environmental Protection. Beginning in September, Massachusetts DEP began trial collections of sorted materials from several of the Permanent Regional Collection facilities. Diversion to domestic and foreign resale and repair markets ranged from 0% in January 1999 to over 70% in September 1999.

Table 2

Massachusetts DEP Market Services Grants
1999 Report on Electronics Recycling Contract

The figures below represent tonnage paid for by DEP following delivery to the state contractor, Global Recycling Technologies (Stoughton, MA). In addition to these figures, individual Permanent Regional Collection facilities have documented diversion through thrift stores or salvage vendors of 20%-70%. Total diversion through the MSG program is therefore much higher.

January – December 1999	FY99 (1st 6 mo.)		FY00 (2nd 6 mo.)	
Perm. Regional Facility	Payments	TONS	Payments	TONS
# Of Pickups, source of material	FY99		FY2000 - To Date	
Boston Goodwill	**$2,346**	7.82	**$3,047**	6.74
5 Charity attended 7-day drop-off				
Chicopee Landfill	**$16,576**	55.25	**$13,342**	24.44
22 Curbside /white-good collection; trailer rental				
Global Recycling – Local p/u	**$3,958**	13.19	**$8,098**	16.18
6 Town 1-day and permanent drop-offs				
Lowell Goodwill	**$0**	0.00	**$693**	2.31
1 Charity attended 7-day drop-off				
Pittsfield Goodwill	**$2,216**	7.39	**$7,411**	17.32
4 Charity attended drop-off, "drive"				
Saugus Salvation Army	**$11,458**	38.19	**$8,158**	22.27
14 Charity curbside, attended drop-off				
Springfield Goodwill	**$10,481**	34.94	**$6,104**	14.65
6 Charity attended drop-off				
Springfield Salvation Army	**$1,188**	3.96	**$585**	1.95
3 Charity curbside, attended drop-off				
UMass Amherst	**$12,514**	41.71	**$27,832**	84.85
15 Town deliveries in bulk; two 1-day				
Approved 3rd Party	**$0**		**$1,337**	4.46
2 (Haulers, recyclers deliver to vendor)				
	Cost	Tons	Cost	
Total:	**$ 60,737**	**202.46**	**$ 58,549**	**195.16**

1999 = 398 tons total, 78 pickups, 5.1 tons per collection

B. Task-by task summary

The actual chronology of the tasks below is listed in Attachment 2. What follows is a summary of each task, which serves as an introduction to the work product listed in the Appendices. Results are described in Section C.

B1 Determine recycling opportunities through analysis of a previous survey of 48 electronics recycling companies. Analyzed data from previous survey to assess employment and diversion.

Prior to the JTR grant award, DEP wrote a grant proposal with UMass that was successful in leveraging funds from the Chelsea Center for surveys of generic electronics recycling markets and CRT glass markets. This data (www.chelseacenter.org/techreptdesc.htm#5) was used to supply employment figures for recycling companies.

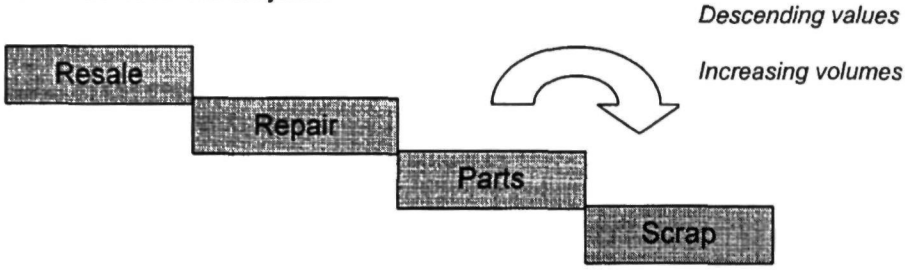
During the JTR research, these companies were analyzed to determine their origins; many were re-contacted, which provided insight to how they have learned one another's secrets; the lines continue to blur between these sorts of companies:

Reuse (components and parts): These firms maximize value by finding components (e.g. an Ethernet card may be worth $25 online at www.uce.com, www.pricewatch.com, www.electronicycle.com, www.recycle.net, www.ebay.com, etc.). The value of this work is important in keeping an affordable infrastructure. The primary barrier to this industry playing a greater role in consumer electronics recycling is specialization. In the past, some of these firms leave unanswered questions about the fate of non-resalable parts. More of these firms now have partnerships or relationships with export and scrap businesses, and will be able to bid.

Export: While these firms were originally in the business of scrap sales (smelting, raw materials, etc.), the Internet economy has caused these firms to blend with Reuse above. Many foreign buyers are now purchasing lots through US-based on-line auction houses (above), as well as through their own sites (e.g. Singapore's http://www.interauct.com.sg/index.shtml)

Scrap: Precious metals recovery and glass recovery have the advantage of simple accounting for materials they accept (as opposed to working or static-damaged memory chips in re-use); they must somehow be involved in the recycling operation if it is to

Market Niches of electronic recyclers



Appendix B lists the 1998 research.

B2 Determine repair opportunities through a survey of 326 television repair shops serving Massachusetts. Prepared textual overview and provided 5 page spreadsheet of individual repair shop surveys, showing employment and diversion. Provide technical assistance and follow-up to any businesses expressing further interest in the program.

Prior to surveying the Massachusetts repair industry, secondary research provided information on the state of TV repair – and HDTV repair. A summary of this research is provided in Attachment 3.

The intent of the survey of TV repair shops was to find if any of them might be willing to play a role in either collection or subcontracted processing of used televisions. The survey uncovered a widespread industry (326 shops in the Massachusetts yellow pages) in deep stages of decline (over half expected to close the business without reselling it in the next 5 years). While not many of these technicians expressed an interest in competing for material in the state contract, just 1% of their membership would double the current in-state bidders expected.

DEP visited the trade organization's (Electronics Technicians Guild – ETG) monthly meeting (1/99), and had follow up meetings with the president and vice president. DEP also toured Sony Corp.'s certified warrantee repair facility, and contacted three large appliance (white goods) collectors. As a result of this work:

- One TV repairer, Dick Peloquin of Advanced Electronics, participated in trial collections from UMass, diverted 20% of the UMass one-day collection event material (at a positive revenue). Following the trial, Advance Electronics incorporated as Electronicycle and entered the business as a partner with Envirocycle and won TV recycling from a Connecticut state contract. DEP visited this repairer on 2 occasions to provide technical assistance and to ensure that the materials were being handled in a way to maximize recycling and environmental protection.

- One White Goods handler, N.E. Appliance Recovery, participated in trial collections from 3 Permanent Regional Facilities and diverted 60% of the material to export/repair markets at no cost to the state. Following the trial, N.E. Appliance Recovery incorporated as CRT Recycling Inc. and entered the business as a partner with two overseas electronics refurbishers. DEP staff visited the site on 2 occasions to assist the business and to ensure that materials were being handled in a way to maximize repair and recycling. A second white goods collector announced that the company would accept CRTs along with white goods collected, for delivery to the state vendor, following the Springfield curbside model.

This task was also extremely important as a way to "prove" markets in foreign countries. For materials, which are not economical to repair in the United States, it is quite realistic that they could be repaired in a country more tolerant of "lagging edge" technology, where labor costs are lower. For materials, which are not technologically, sound to repair, it is doubtful that an export market has special techniques not available in the US. By first understanding the domestic repair market, MA DEP was able to communicate with foreign repair markets.

ATTACHMENT C

B3 Determine repair opportunities through a survey of monitor repair shops. Prepared analysis from interviews with ten monitor repair companies who subcontract work from computer repair firms, showing employment and diversion.

Secondary research was performed to better understand the repair industry before a survey was undertaken. The following links provide the best sources of understanding of the repairability of monitors.

> **Notes on the Troubleshooting and Repair of Computer and Video Monitors**
> Written by Samuel M. Goldwasser Most recent version is available on the WWW server http://www.repairfaq.org/. An excerpt of Mr. Goldwasser's text is shown in Table 4.2 of Attachment 3.

> There was no statewide organization or meeting of computer or monitor repairers to introduce the survey the way ETG introduced it to TV repair members. Computer repair facilities were numerous but were far less likely to spend time on the telephone survey (they also seemed to be much busier, perhaps with Y2K issues). DEP's consultant, Bill Waters, identified 10 monitor repair specialists willing to participate. Employment per ton was quite high, though the respondents cited some of the same lack of willingness by Americans to consider repair of monitors, which were less than 17". Because of changing US monitors standards, VGA monitors were not considered worth repairing domestically – though it is technically quite feasible.

B5 Determine reuse and repair opportunities through a survey of overseas export markets.

> DEP's consultant, Patricia Dillon, surveyed export markets to identify employment and repair practices. Meanwhile, DEP posted the availability of non-working monitors on some web-based trading services, and got numerous respondents willing to pay for monitors FOB Massachusetts collection points. The specifications for these markets (no screen burn, no monochrome, no vacuum tube disturbance) reinforces that these are NOT scrap material markets, but repair markets. UMass demanufacturing program also failed to find any valuable scrap in the monitors they took apart.

> Attachment 4 is Dillon's report on Export Markets

B1 Determine what happens now through a survey of 800 Massachusetts households. Prepared over 100 pages in statistical analysis of behavior and demographics (Table 1 below and Attachment 5).

> The attached summary shows an enormous level of detail. The survey showed how most residents handle their non-working TVs and computers. TV ownership was nearly universal (though a minority of households possess most of the TVs) 32% of respondents had a TV stop working in the past 5 years; of those 37% threw it away, 20% put it in storage. 40% had a computer stop working but only 1% had ever thrown one away. Below are some excerpts of the first study:

Of Massachusetts Households:

- 99% own at least 1 TV (2,275,560 households)
- 43% own AT LEAST 3 TVs (998,460 households) and 37% of all TVs are in 20% of the households).
- 32% of all households had a TV stop working during the last 5 years
- Only 21% of those had the TV professionally repaired. The rest of households put the TV in storage (20%), threw it out (37%), or "passed it on" (sold, donated, or gave it away) (21%
- 59% of households own at least 1 computer (1,356,270)
- 40% of those have a computer they have stopped using.
- Only 16% of these had the PC repaired. The rest put the PC into storage (33%) or "passed the buck" (sold, donated, gave it away). Only 1% threw the obsolete PC in the trash.

Storage and passing the buck are the biggest concern. DEP expects a "wash out" of old units over the next 10 years, due to 2 developments which will affect the whole country: HDTV, and an impending "baby boomer tag sale" as more Americans retire or move on. Unless an infrastructure is created to recycle these items, the effect of the waste ban will probably be more storage.

B6 Analyze trial collections through municipal drop-off programs. Analyzed ease of implementation, inventory of items captured at several of these collections.

In the fall of 1998, for $17,000 plus the cost of disposal, DEP funded a one-day collection pilot in three locations in Franklin County Mass. This material was delivered to UMass for analysis, demanufacturing time studies, brand inventory, and other samples, to determine the most appropriate markets. The event yielded 17 tons, and a final report, which provided DEP with a basis to pursue the program in other areas.

While the drop-off program was successful in this rural area (which does not have a charity program or curbside bulky collections), it was labor intensive and failed to keep materials triaged in a way, which promoted reuse. One of the most important findings was that large deliveries of materials from schools and community colleges should be diverted from one-day events and delivered directly to processing facilities.

In the spring of 1999, DEP repeated the event but first publicized that individuals could bring in their electronic items directly to UMass. Franklin County and other municipal officials hosted the event at UMass on two Saturdays. Dick Peloquin of Advanced Electronics TV repair attended and diverted 20% of the televisions for parts reuse and repair. Double handling and transportation costs were also eliminated. While convenience to the event was less than it had been in the previous 3 drop-offs, events can always be held later (after diverting as much as possible).

The original Franklin County report is presented in Attachment 6

B7 Implement trial collections through municipal curbside program. Analyzed ease of implementation, cost of diversion and capture rate.

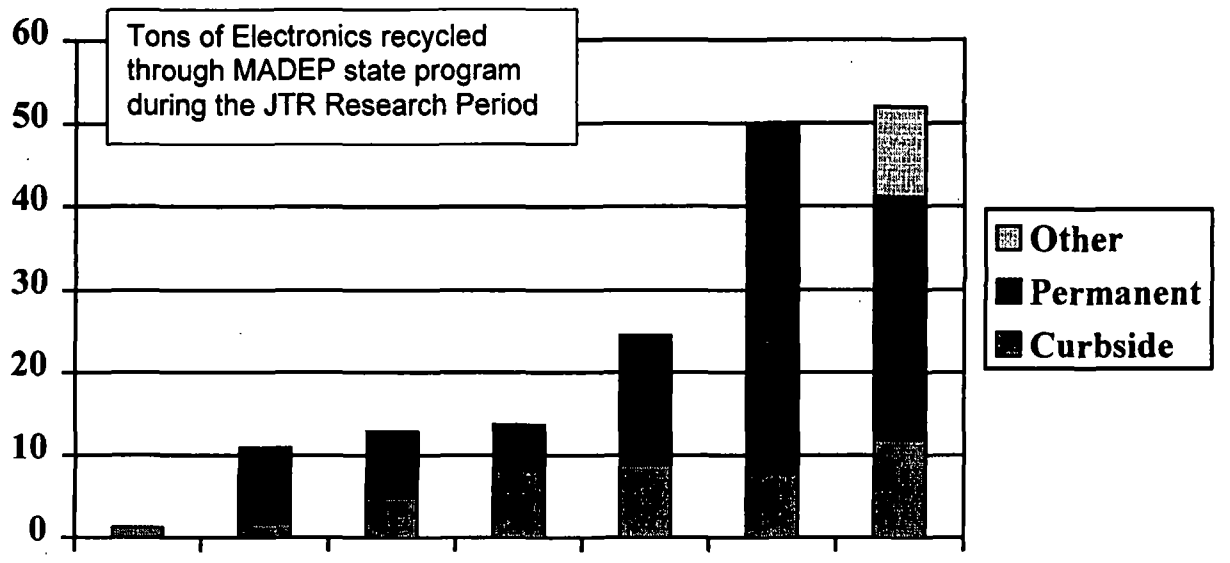
Under the direction of Michael Pattavina, Recycling Director for the City of Springfield, that City became not only the first host of 2 charity partnerships (Goodwill and Salvation Army both have processing facilities in Springfield) but also the first curbside bulky waste collection Pilot. DEP offered to pay recycling fees for all electronics deposited in a separate trailer, located at the local landfill. The results of this pilot are presented in Section C.

B8 Implement trial collections through partnerships with used goods reuse non-profits (Salvation Army, Goodwill). Analyzed ease of implementation, cost of diversion and capture rate.

From January to June 1999, residents were invited to bring TVs or Computers to any of 10 permanent regional facilities in the state. Most of these facilities are Goodwill Industry or Salvation Army facilities with their own extended collection network. In return for accepting broken or obsolete TVs and computers, these agencies receive free recycling of any they can't repair or resell – typically 50% of their donation stream (See Table 9 on page 26 for a summary of results).

Collections began at 21,780 lbs in January, and grew 40% per month (See Figures 2 and 3 on pages 27-28 for a breakdown by month and by collection center). In June, 104,907 lbs. were recycled – approximately 3,500 TVs and computers. DEP reports that its unique single-payer contract and regional, bulk collections cut prices 40%. The charities have also diverted 20% more CRTs to resale (to TV repair facilities as well as to consumers), which comes off the top of the contract (See Table 10 on page 29 for an example). Most municipalities, which do not touch the material, see an additional pure avoided disposal cost of up to $65 per ton.

See Section C for details.



B9 Implement processing tests of municipal material through de-manufacturing at the University of Massachusetts. Analyzed through samples of material by brand, by item, and by de-manufacturing time per item. Samples sent to repair markets at greatly reduced cost, introduced those markets to the material being recovered from those municipal programs.

UMass processed over 79 tons of material from July of 1998 to June of 1999 (including material generated at UMass). Through the JTR research grant, UMass added residential materials to the de-manufacturing process, performed time studies, sampled brand names, etc. Lorenzo Macaluso, the project coordinator for UMass, also kept records of municipal deliveries and organized recycling collections, not only through the central state contractor, but also through trial repair contractors seeking to experiment with contracting or demanufacturing.

See Attachment F: Results of UMass Electronics Processing

Beyond the research provided through the attachment, UMass provided as successful model for the 4 Goodwill Industries hubs, 4 Salvation Army hubs, and Amvets processing center, which were invited to participate as Permanent Regional Facilities. The high acceptance rate (4 Goodwills, 2 Salvation Armies) was in large part due to UMass providing a "cookie cutter" – those facilities were not only presented with a concept and a draft agreement, but also a model facility.

The complete report is presented in Attachment 7

B10 Analyze which markets are most accessible through each trial collection program.

Section C. presents the importance of triage to get materials to the markets, which are most affordable, most employment intensive, or most environmentally sound. Basically, if Apple computers are best salvaged by an Apple computer specialist, the collection must allow time and space to sort and analyze the Apple equipment. Stretching deliveries over time best does this, yet the material should also be protected from theft during the meantime (while theft does reduce volume, it's impossible to determine the environmental or employment consequences, or to know whether the item taken was even reusable).

B11 Analyzed data to assess employment and diversion.

Dr. Bernard Morzuch of the University of Massachusetts Resource Economics Department reviewed secondary research and the results of surveys above to determine the employment ramifications of different asset management techniques. The analysis shows that recycling (mainly demanufacturing through the 48 recycling companies) does generate significantly more employment than solid waste disposal. However, repair and reuse generates even more employment. Even the export markets generated more domestic employment than disposal. After a visit to a large exporter in Rhode Island (Fortune Group), this was attributed to the careful handling, inventory, and monitoring of loads (as opposed to pushing dirt on a pile of material at the landfill).

Attachment 8: Academic analysis of employment ramifications of different recycling strategies.

C. Core measures.

Four core measures are the focus of this JTR project: employment, capital investment, capacity, and utilization. As an optional measure, MADEP compares different systems to measure the efficiency of each to divert secondary material for disposal. Efficiency (most items collected and recycled at least cost) of each end market was compared based upon our estimates of the average amount of material which could be resold, repaired, or recycled for scrap under each handling method.

These core measures are first compared across the 4 generally identified end-markets: repair/reuse, recycling, export and disposal. Afterwards we compare the different collection methods according to the way they emphasize these end markets.

Changes in markets	Total Tons	Cost	Units	Unit cost	Recycled Est.	Resale/Repair/Export
1998 – Before JTR research	30.4	$15,200	1,522	$9.99	100%	0%
1999 – After JTR research	*460.0	$110,160	22,949	$4.80	60%-75% est.	25-40% est

* Est. minimum 25% diversion before state contract (367.2 tons). Not all Permanent Regional Facilities weighed or documented resale and repair weights; 2, which did, exceeded 50% diversion.

Because the cost of recycling was reduced by both collection systems (PRFs) and reuse markets (domestic and export), the state was able to extend the grant farther. The extension of the grant led to more tonnage and more employment for the domestic recycling firms as well.

Employment: Details of the employment analysis can be found in Appendix E. To estimate the employment, the tons collected through each measure were pro-rated based on employment: ton figures calculated by Morzuch in the preceding table, according to the percentage of the material which was feasibly diverted for repair or export or recycling under that method. The repair employment seems high, and it may well be exaggerated by underemployment of the TV repairers surveyed (it's doubtful many of the repairers were earning the $35K postulated in Morzuch's analysis). Nevertheless, some kind of exponential employment factor can be explained by the retained value of a complete appliance: if 50 appliances per ton are repaired for a resale value of $50 apiece, the $2500 per ton could be spent to employ people to do those repairs.

Table: Employment comparison of electronics diversion methods

1000 tons of CRTs employs		0.04 FTE through land filling
	or	0.07 FTE through incineration
	or	1.9 FTEs through recycling
	or	3.6 FTEs through export
	or	**142.9 FTEs through repair and resale**

Capital Investment: New capital investment is actually highest for recycling, lower for repair and export (disposal requires no new investment). The most notable capital investments made through this project – CRT glass processing at Global Recycling Technologies ($45K), and Plastic recycling at Conigliaro Industries ($165K) – were far larger than any investments made by repair or export firms. However, this can be attributed to recycling being a fairly new activity. If we consider the repair investments already made (326 TV repair shops in MA alone), and the fact that over 50% are at risk of closure in the next 5 years, the net investment preserved through repair is considerable.

Capital Investment

	Repair	Recycling	Export
Current	326 businesses Est. capitalization $40M ($125k / business)	48 businesses Est. capitalization $48M ($1M / business)	12 businesses Est. capitalization: $100,000 only (offices)
New	50% decline projected	3 new electronics recycling investments in 1999; $300,000	New emphasis on foreign repair; no US investment therefrom

Capacity: Capacity can be measured either as distinct markets (reuse, recycling, export) or as a cumulatively, if different components can be sent to different (specialty) markets. Diverting different electronics components to different specialty markets was only possible through the Permanent Regional Facility (charity) model described below. In this case (84% of material collected); once materials were commingled on one-day collections or through curbside programs, the capacity to reach specialty markets is reduced. Diverting an Apple computer is a bonus to a PC recycling firm: a foreign reuse market for an older TV is a relief for a domestic repair firm without a sales market for the older TV. Therefore the capacity of the market for CRTs has been increased through the JTR grant, by using different markets to augment one another.

Capacity

	Repair	Recycling	Export
1999	20,000 tons per year	Needed for bottom 20-60% 12,000 TPY	Fluctuates; controls material not good enough for domestic repair.
New	50% decline in repair shops projected; capacity for 5,000 tons will be lost (smaller businesses)	3 new electronics recycling investments in 1999: 3,500 tons capacity added	Most important: Mexico does not anticipate HDTV; China has an official 1 PC per home policy. Potential capacity in billions of pounds.

Utilization The state contract utilization of different markets is also related to the collection methods. The "one day" drop off method used in Franklin County (the first collection program) resulted in 12 tons of material being bulked in a way, which was difficult to triage, despite UMass PRF capabilities. The charity programs, by

comparison, spread such a 12-ton amount over several weeks of individual donations, allowing those facilities staff the time to segregate, test, and triage equipment.

Utilization

	Repair	Recycling	Export
Current	Increasing	Increasing	Level
New	Increasing, as a percent of finance	Steady growth	Untapped potential

The way the core measures were affected by each different collection model is compared by collection model below.

Private-Municipal partnership.

Tons	Total Cost	Population served	Repair/Resale Employment (40%)	Recycling Employment (60%)
169.1	$40,585	1,318,201	9.6	0.36

Grant period only

This model generally saved the municipalities from any organizing or handling costs, yet the municipality benefits from avoided disposal and transportation costs. The state benefited from an average 20% diversion through resale during the first 6 months of the program (this diversion increased in the following 6 months, after the JTR reporting period, to as high as 60% at some facilities). The state contractor offered a 40% price reduction over one-day collection events because of the ease of collection at charity loading docks (large quantities on pallets); this discount only applied to drop-off and curbside programs whose materials went through a permanent regional facility or consolidation point. This model was most efficient where an existing charity (Goodwill, Salvation Army, etc.) is already serving an area; private repairers and recyclers are now offering the same service (collecting directly from residents for a small fee). The population served reflects the communities, which had agreements with charities by June of 1999 (some of these programs only began during the last month of the reporting period, so tons per resident cannot be calculated meaningfully). IMPORTANT: The municipality or the state MUST agree to pay recycling fees for this model to work!

Curbside (bulky waste):

Tons	Total Cost	Population served	Repair/Resale Employment (0%)	Recycling Employment (100%)
55.25	$17,775	150,000	0	0.1

Grant period only

The curbside program was only performed in one city (Springfield, MA), which was also served by 2 charities. Since the TVs and computers were already being collected separately in a "bulky" waste truck, the city merely had to stop before the weigh scale to off-load the CRTs into a separate trailer (rented at $200 per month by the state contractor, Global recycling). Some extra time was involved in handling CRTs separately, but no overtime was involved and some of this expense would have been offset by avoided disposal costs. No diversion to repair or resale occurred in this model, making it easy to implement but less efficient than the charity model. This program results in more employment (through recycling) than disposal, but less employment through repair than the charity model above.

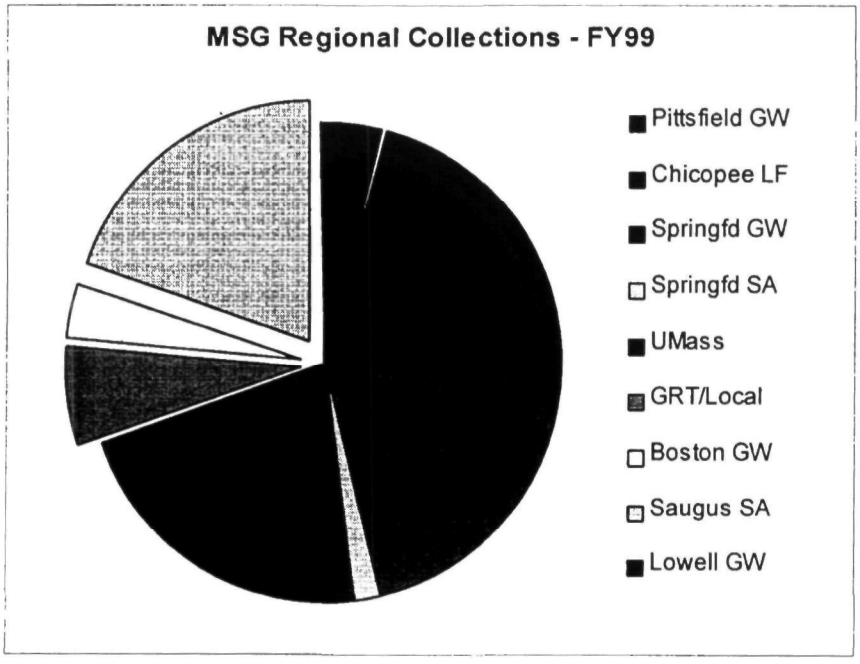
Drop-off:

Tons	Total Cost	Population served	Repair/Resale Employment (10%)	Recycling Employment (90%)
27.8	$18,775	90,284	4.0	0.05

Grant period only. TV Repairer attended and intercepted materials at the spring one-day collections

The first drop-off program in Franklin County had materials double-handled through UMass (collection and handling employment is not considered in the core measures); normally, however, there would be no intermediary site to examine resale and repair alternatives. During a second set of trial drop-offs, held at the UMass facility in the spring, a TV repair expert was invited to actually attend the event. He succeeded in diverting 20% of the day's materials, and provided a repair/resale accounting (Attachment 5).

Pilot collections in FY99



GW = Goodwill, SA = Salvation Army

D. Other measures.

Convenience of access and participation:

The attended Permanent Regional Collection Centers (charities) not only diverted the most material to repair and export markets, but they also offered inexpensive, "turn-key" programs for most municipalities in the commonwealth. A municipality benefits from the avoided disposal costs of CRTs collected through those programs, but has virtually no labor or handling costs. Furthermore, these programs capture other materials not even targeted through this research – clothing, shoes, bric-a-brac make up most of the materials collected at these charities, which may see TV recycling as a "loss leader" to attracting participants. The charities, which picked up house-to-house (curbside), gathered far more large, console type televisions (these programs were also less happy with the program in general, because of the extra work involved. MADEP recommends that municipalities pay charities on a per-unit basis for door-to-door/curbside collections.

The weekly curbside program in Springfield had the highest participation rates. This is no doubt due in large part to the fact that trucks collected TVs and monitors on trash day – even "non-participating" CRTs were captured through this method. While diversion to higher employment markets like repair was less feasible, the low start-up cost and the high Participation rates make this method well worth considering wherever a municipality has such a bulky waste collection program in place. The curbside program got far larger, console TVs than other types of collection programs; these were initially thought less repairable, but one export/repairer has since developed a market for them.

The one-day collection programs initially showed higher diversion than the charity model. However, the same diversion rates were achieved in trials where charities were promoted on a "limited time basis" (e.g. Pittsfield, where Goodwill advertised a "June only" program, and at the one-day events held at UMass's permanent regional facility). These programs are probably more appropriate in rural areas which do not attract the interest of attended charity trailers, and which do not have seasonal collections of CRT appliances. These events collected a smaller percentage of large, console items.

E. An explanation of the lessons learned.

The hierarchy of reuse, repair, recycling and disposal held true for job creation as well as environmental policy. The ability of a collection program to triage individual appliances to these uses was affected by the time, space and expertise available. When computers and televisions were collected through permanent regional facilities, access to private TV and monitor and computer repair companies increased.

Monitors, televisions, CPUs, keyboards etc. are complex, durable goods with an extremely high added value per pound. Even one repairable or resalable item (or part) out of ten will dramatically affect the cost of recycling. This fact alone makes their collection and recycling different from lamps, batteries, bulbs, tires, paper, containers, etc. For illustration, see how a 1% resale can affect the average recycling cost:

100 TVs (50lb) recycled at a cost of 15 cents/lb = $750
99 TVs (50lb) recycled @0.15 and 1 TV resold at $75 = $667.50

A 1% rate of resale reduced cost in the above example by over 11%. Like a MRF, which doesn't bother to separate aluminum from steel, an electronics recycler ignores resalable parts and items at its financial peril. By salvaging the value already added to a computer or television or its components, a company can greatly add to its employment.

White goods (kitchen and laundry appliances) are the most similar item in the waste stream in terms of value, retained value, parts, etc. The largest white goods specialty processor in Massachusetts handles 125,000 tons per year of these appliances. Of those, 40% (50,000 tons) are handled through resale of parts and complete appliances, largely to lesser-developed countries where low labor rates and high repair skills keep older appliances in demand.

All of the charities handling durable goods told us that at one point, usually "15 or 20 years ago", that they accepted and collected white goods appliances and performed minor repairs. Now, many are afraid to accept them at all, and those which do insist that they collect them from the home, plugged in, with an assurance that they are in good working order. The 1989 Waste Ban on white goods drove too many appliances their way, and the crack down on PCB capacitors and freon made disposal of those appliances too expensive. But the lesson learned is that the charities cannot handle these appliances for free. With many Massachusetts communities now paying up to $25 per appliance for disposal, it's possible that the charities could have continued what they were doing if treated like a municipal contractor, rather than as a "free lunch" by residents seeking disposal.

The value remaining in some percentage of computers and televisions affects the way which electronics should be collected. Collecting these items in a packer truck might be the most efficient method from the point of view of a municipal DPW director who has such a packer truck standing idle (some loads delivered to UMass during the pilot were thrown commingled onto trucks and dumped on the picking floor). However, this method – treating electronics as wastes rather than as a commodity – makes triage of appliances with a retained value difficult or impossible (cords are entangled, pieces come apart, and tubes may be broken). The determination that a computer or television is a "waste" and not a commodity should not be made by a truck driver whose performance is judged by how quickly and efficiently he performs his route.

The "flip side" of job creation is labor cost. Examining and testing appliances for resale and repair value is time consuming. The ability to examine items for repair and resale was greatly enhanced when these items were collected at permanent regional facilities, such as charitable reuse centers; the fact that more items are collected in a one-day event can actually work to the detriment of a recycler who is trying to keep the items safe and intact for testing.

Where one-day events are necessary, having a television or computer repair expert on-site can reduce costs. While it is not possible to test a significant number of items on the day of the event, such experts can identify the appliances, which are most likely to be repairable, or resalable.

The lessons learned during this study have already been adapted elsewhere. Three private recycling companies have begun opening chains of "thrift stores". Charities have approached software companies asking for relief from licensing restrictions, so that more of the computers can be given out (helping to close the "Digital Divide"). During the writing of this report, two additional white goods collectors contacted Mass. DEP asking for information to add CRTs to their existing collection programs.

F. A discussion of the challenges overcome.

The challenge reusing computers and televisions and their parts domestically and overseas was overcome by establishing permanent regional facilities, capable of receiving the material year-round and preparing it on loading docks for transport. Interviews with television repair, monitor repair, and export (for repair) industries led to new markets; this information was shared with private recycling companies who have now all greatly increased their diversion of working and repairable televisions, monitors and other parts. Despite this success in overcoming market challenges, we identified several new challenges to improving the market even further.

Software License. A year ago, before the emphasis on Reuse, software was not even considered a part of the computer waste problem. But once computers were set aside for potential resale, the real problem became clear. Resale of computers is a moving target, due to the rapidly changing software requirements. 486 computers, which charities could sell at a profit 18 months ago, are now almost impossible to find software for. Some resellers leave the old (windows 3.1) software on the salvaged computers, without finding out whether the original owner retained the license. Proposed solution: bulk volume purchase of software designed to run on older PCs, either through state license or by pre-installing "spare tire" software hidden on the hard drives of new computers. This can be accomplished either by state purchases, EPP procurement, or licensing by OEMs. The point is to allow at least an operating system to remain with a surplus computer, so that a new buyer is not forced to "experiment" with an expensive license, which probably does not even fit on the hard drive.

Technical Assistance: Technical expertise in information technology is difficult to obtain and maintain even at banks and manufacturing plants; obtaining and keeping this expertise at a demanufacturing or recycling plant or at a charity is even more difficult. This expertise is necessary to perform the highest environmental and employment-per-ton activity, re-use. The savings achievable through repair and resale triage must be offset somewhat by the need to recruit technicians. Proposed solution: Charities are adept at leveraging funding for "job training programs." At least one New England charity which recycles computers has already used the recycling program to win a job training grant (the technician is hired to train, repairing is a secondary benefit. Some "horse trading" (finding technicians who have another source of income, but who are interested in working part time in order to find a source of parts) has also been used successfully by Reuse centers. Rather than investing in one technician (who may know Apple but not IBM, or who may specialize only in TVs) subcontracted hours to CRT specialists for each device can be effective. This can also be effective for private recyclers.

Missing Hardware: Lack of modems is another challenge in older PCs. Lack of cords is a problem with printers. The costs of these items (about $25 per modem, $15 per printer cord) and the cost of technician installation move the price of a donated CPU from $0 (assuming handling is covered by a tip fee) to $50. If web browser software costs $79 and a technician spends another $25 in time installing that software, the used PC cannot compete with low-end machines on the market. Proposed solution: Like automobile "chop shops", the resale market will begin to create a market for parts, which are now thrown away or recycled. Lowering the cost of the software (above) is also critical to make the modem investments less of a burden.

HDTV: For televisions, HDTV transmission promises to be a long-term barrier. The cost of new HDTV machines may be a short-term opportunity if consumers resist replacing their TVs until HDTV prices have fallen. Over the longer term, however, this market will implode. Proposed solution: continue investigating Mexican and South American markets (same power supply requirements); those markets are not expected to convert to HDTV. A healthy market already exists for export sales of "high end" televisions (e.g. clean outs from hotels and motels); by converting to a tipping fee rather than positive payment from the southern markets; more TVs may be economically repairable in these countries.

Regulatory Uncertainty: At the beginning of this project, EPA Region I, EPA Region III, Common Sense Initiative, and Mass DEP had four different regulatory interpretations of the status of CRTs, which commonly fail EPA's TCLP test for lead. Without getting into the particulars of RCRA, the disagreement had a chilling effect on the infrastructure, as recyclers and reusers doubted their own status and responsibilities. Solution: While EPA headquarters is still determining whether CRTs are a scrap metal, exempt only in "glass to glass" operations, a universal waste, or a hazardous waste, DEP and EPA Region I have reached an agreement. In essence, the REUSE emphasis of the Massachusetts program is exempt, because "repairable" or "reusable" monitors and TVs remain commodities, not wastes, until they are discarded. This agreement (on the word "waste", not the word "hazardous") allowed the Massachusetts program to grow and succeed during the interim.

G. An overview of the program's future.

UMass, 4 Goodwill industries, and 2 Salvation Armies have opted to continue the program. Trial shipment to CRT specialists (TV repair, circuit board recyclers, overseas monitor exports) has dramatically lowered the cost during the fall of 1999. However, most of the material is still collected under state CRT recycling contract.

The central state contract achieved a 40% price reduction and a dramatic economy of scale. The Permanent Regional Facilities have achieved as much as 50-70% no-cost diversion (through resale, CPU sales, and sale of repairable TVs and monitors) before that state contract comes into play. If the diverted tonnage is estimated at 50%, the cost of recycling has been less than $150 per ton, or $3-4 per TV or computer.

Nevertheless, there are risks that the contract will be perceived as a "subsidy" over the next year. For the long term, MA DEP must strive to bring costs low enough to be paid willingly through user fees (like tires); otherwise, special funding devices such as advanced disposal fees may be necessary to continue the program.

The economy of scale in the bulk contract, the organized "cherry picking" of resalable parts and appliances (through thrift stores or subcontracted electronics specialists), and the avoided trash handling and trash disposal costs achieved by municipalities using charities have succeeded in bringing the average CRT cost to below $5 apiece. 79% of Massachusetts residents said they would be willing to pay $5 per CRT to ensure it be repaired or recycled through reuse.

Unfortunately, the charities do not accept payments at their drop-off and curbside collection programs (many of which are staffed by "rehabilitation" clients). For this program to work, municipalities must be willing to pay the recycling fees of leftover

appliances, through the existing state contract. A trial municipal charity contract is in place between Northampton, East Longmeadow, and Longmeadow MA with the Goodwill Industries of Springfield.

Private 3rd party collectors are beginning to play the same role as charities, using domestic and overseas markets to maintain the value of more value added appliances. Envirocycle of PA has now joined with Advanced Electronics (a TV repairer in Massachusetts identified through the JTR grant). DMC of NH now exports most monitors to overseas repair companies. Appliance Recovery Inc. of Freetown, MA has added televisions and computers to the list of items it collects from cities and towns, and now provides FREE collection of TVs and monitors from charity PRFs (30 day terms).

All of the parts are now in place to maintain an inexpensive, effective, turnkey infrastructure, which will take little time or money from existing municipal recycling resources. With an emphasis on increased diversion at all PRFs (through software, technicians, and specialty scrap vendors) and a competitive rebid of the state contract, MA DEP hopes to bring average costs of TVs and computers below $175 per ton. This price would be roughly in line with average solid waste collection plus disposal (though not necessarily a wash in any individual community). If this can be achieved, we recommend that legislation efforts be left for other wastes, which pose more of a dilemma than CRTs and electronics.

Table: Documented Diversion to reuse and free recycling

Data of diversion at Morgan Memorial Goodwill Industries (Boston). Eight months of operation (some TVs and computers remain in the processing center; diversion is about 60% through scrap CPU, TV, and repairable monitor sales.

Global Technologies	Arlington	Boston	Newton	Other sites
TVs	34	58	41	140
Monitors	27	78	35	201

this is what we have sent to global technologies

Received from Sites				
Tvs	Arlington	Boston	Newton	Total
May-99	39	65	36	140
Jun-99	36	63	32	131
Jul-99	23	51	19	93
Aug-99	25	60	19	104
Sep-99	19	59	17	95
Oct-99	20	39	8	67
Nov-99	17	40	8	65
Dec-99	4	12	4	20
totals	183	389	143	715

this is how many TVs we have received from the 3 sites

Monitors	Arlington	Boston	Newton	Total
May-99	34	44	33	111
Jun-99	27	39	22	88
Jul-99	19	29	14	62
Aug-99	10	28	9	47
Sep-99	11	49	10	70
Oct-99	19	24	8	51
Nov-99	8	26	9	43
Dec-99	7	9	2	18
totals	135	248	107	490

this is how many monitors we have received from the 3 sites

H. Attachments of all resources and documents developed during the grant.

Integrating Markets and Infrastructure Development

The overall approach Massachusetts Department of Environmental Protection has taken is to research and develop recycling markets most likely to sustain a residential collection infrastructure. In this section we present the reasoning behind the research products that follow.

Recommended Approach:

1 TARGET THE BULKIEST MATERIAL (CATHODE RAY TUBES)
2 ASSESS THE CURRENT MANAGEMENT METHODS FOR THE BULKIEST MATERIAL
3 RESEARCH (AND DEVELOP) MARKETS FOR THE TARGETED ITEM
4 DEVELOP REGIONAL COLLECTION SCHEMES
5 INTEGRATE MARKETS WITH COLLECTION SCHEMES
6 RESEARCH JOB CONSEQUENCES

1 TARGET THE BULKIEST MATERIAL (CATHODE RAY TUBES)

It's possible that cell phones, mercury-switch devices, laptops, or defillabrators will be the most valuable (financially or environmentally) items in the electronics recovery stream. However, the largest cost of residential recycling is collection from every household. While the JTR grant does not study transportation, we focused our research on the items, which would be at the core of a collection system. Unless CRTs are excluded from electronics recycling, their collection will drive the cost.

It will be easier to add small items such as telephones to a system, which is already designed to capture televisions and monitors. The need for public acceptance, understanding and participation is another reason to target a message around obvious, bulky materials.

Cathode Ray Tubes (CRTs) are the bulkiest electronics waste item, and "TVs and Computers" was a fairly easy message to get across to the public. Collection of these durables from the majority of households would represent the highest cost of the program (cheaper collection methods would not capture them from the majority of residents).

2 ASSESS THE CURRENT MANAGEMENT METHODS FOR THE BULKIEST MATERIAL

Paper and plastic recycling began with commercial accounts and evolved to consumer drop-off programs, where material could be consolidated in quantities attractive to the existing infrastructure of commercial paper recyclers. Just as curbside recycling eventually required fundamental changes from commercial paper recycling, convenient access to collection of consumer electronics will require a broader base of collection.

Following the same drop-off model as was first used for papers and plastics, several pilot programs have been held nationally (Somerville, MA; Binghamton, NY; San Jose, CA; Hennepin County, MN; Union County, NJ). The reports were very useful for the purpose of this study. Most of those pilots used drop-off model to simulate commercial loads of material. However, a handling infrastructure already exists for used TVs and computers. Rather than the existing asset management systems for used the television and computers.

The handling system for durable goods like TVs and computers is complex. As durable goods, these materials are repaired, resold, and recovered for parts. As such they are not actually "wastes" any more than a used car is a waste. Another difference is that households deal with these items irregularly, and tolerance for storage by the consumer is often high (except when a real estate transaction is involved).

If we assumed that the collection infrastructure for used CRTs was going to be the same as a drop-off program in Somerville Massachusetts, the list of markets to survey would be narrow. However, this research took a much broader view of collection and handling. Below is a list of useful observations about CRT management and disposal.

1. Cathode Ray Tubes represent the most difficult electronics recycling market, as well as the single most bulky component of the electronics stream 2. CRTs are present in over 99% of Massachusetts's homes (about 2.2 million households).

3. CRTs are becoming "obsolete" (for that user) at a rate faster than they are being discarded. This trend could lead to a massive cleanout due either to demographics (aging baby boomers) or HDTV technology changes in the next decade.

4. CRTs discarded in solid waste are most likely to be crushed by packer truck blades, where they are most likely to implode, and most likely to injure workers.

5. Residents are slow to discard items for which they paid over $200.

6. Residents are slow to repair items that can be purchased new for less than $300.

7. Residents are three times more likely to buy a used TV/computer than to sell one.

8. There are 326 TV repair shops in Massachusetts.

9. There are 351 cities and towns

10. 68% of Massachusetts's residents have their trash picked up from in front of their homes under municipal contract. 85% have trash picked up from in front of their homes (includes subscription haulers)

11. Consumers repair, upgrade, sell or discard CRT electronics approximately once every 5 years.

12. The number of consumers with experience with repair and resale is apparently declining.

3 RESEARCH (AND DEVELOP) MARKETS FOR THE TARGETED ITEMS

During the 1990's it has been fashionable to think that Markets must precede the collection of items. We certainly agree that collection should follow market research, and it's a big mistake to gather CRTs without a pre-arranged place to send them.

However, the long-term cost of new markets cannot be assessed before an economy of scale is achieved. Forests precede paper mills. Initial pilot collection costs should not justify elaborate legislative remedies (mandatory manufacturer take-back, etc.). While these may or may not be the best solution, there are political limits on the number of legislative measures government will undertake, and it is important to prioritize them.

To better assess the long-term costs, Massachusetts undertook market research concurrently with collections. This allowed the JTR team to ask questions they may not have thought of without an ongoing collection program. It also allowed the team to check market leads by following up with actual sales. For example, a domestic exporter was under the impression that his Asian market would accept monochrome monitors as well as VGA or SVGA monitors; once an actual inventory was presented, he found he could improve his revenues and eliminate sending materials which were likely to become waste products overseas.

- Determine the highest value of items collected (resale, repair, recycling, export)
- Determine who can actualize that value
- Determine where
- Determine how

Anyone who already handles CRTs in the community should be approached for expertise, and offered a chance to be involved. The more local options for handling, the lower handling costs potential.

It is also important that the "cherry picking" of valuable items and parts occur within the asset management paradigm. There are "cherry pickers" that have no knowledge or skill to manage "residue". For a reseller of pentium chips, the "residue" could be 98% of the weight of the computer.

While these individuals can offer valuable insights to reducing the cost of the collection program, they should be brought in "under the tent" of an overall electronics management strategy. In Massachusetts, one company, which processed over 200 tons of material, cited absolutely no resale

value. If this is true, it would represent a strong need for experts who can identify which items have resale value.

4 REGIONAL COLLECTION SCHEMES

The fastest way to come up with an economy of scale and an efficient collection mechanism is to identify places where significant volumes of used consumer goods are being consolidated. In order of volume collected,

1 Collection from individual homes (curbside)
2 Collection at temporary drop-offs (events)
3 Collection at permanent, attended centers

DEP consciously avoided collections at Household Hazardous Waste events. The licensed site professionals who attend these collection days, dressed in white haz-mat suits, charge by the hour (either directly or through their bid). Adding ANY material, which does not require a haz-mat technician to the line of cars, is costly. If 25% more cars came in carrying pitchers of water, the cost of handling that water would be tremendous, both in terms of hours and in the environmental costs when the long line discourages other drivers with hazardous items.

5 INTEGRATING MARKETS WITH COLLECTION SCHEMES

Overall, the economy of scale addressed above was more quickly achieved when existing accumulations of unwanted CRTs were targeted at charities and bulky waste collections. In rural areas, short-term drop-off programs were necessary to maximize volumes for transport. In moderately populated areas, month-long "TV and Computer 'Drives"" at charities were effective.

The time, space and labor available to handle and assess material for repair and resale make a significant difference in the market. For example, if an export market for repair of monitors has no tolerance or ability to manager TVs, monochrome monitors, or monitors with "screen-burn", it is necessary to have the time and space to triage the collected monitors. A one-day drop off program at a municipal yard makes that unrealistic.

The need for "cherry picking" to occur within the management paradigm also constrains the marketing of electronics. The curbside "bulky" collectors in Springfield, for example, cited many instances where a TV called in by a previous truck had "disappeared" from that address when the bulky recycling truck arrived. Presumably, someone with an interest in reuse or repair had scavenged the item. Whether they were actually able to fix it is a mystery; also, avoided collection costs are compromised when the scavenging is random (the truck drivers don't know whether an item is still there until they get to it).

In order to gain their participation in the program, Salvation Army and Goodwill Industries were offered "amnesty" for CRTs they cannot resell. The state contractor collects truckloads of palletized

TVs and computers from each charity's central processing facility (as opposed to satellite thrift shops and collection centers) and bills the DEP. The state gained a 40% price cut from the contractor, who was able to cut trucking costs (several cities materials were consolidated at these facilities).

Resale: All of the charities had a resale/thrift market outlet for TVs and PCs they collected; UMass did not have such an outlet. In the Boston area, Salvation Army required each item be "tested" before it was sold – management believes that "returned" items are a cost to be avoided. The Boston Goodwill provides plugs in the store and encourages testing by the customer, but puts almost all TVs and PCs up for resale. Goodwill management believes that "do-it-yourself" repairers and professional repairers are part of their resale market.

Repair: Professional TV repairers should be invited to visit UMass, Goodwill and Salvation Army. In each case, the repairer may be willing to take items from the stack for free or for a greatly reduced rate – but only if these items are separated and kept in another floor space. Unfortunately, the "amnesty" contract does not give the charities an incentive to pursue this extra effort.

Scrap market: Salvation Army went to some effort to separately bid collection of CPUs, and also had staff strip the wooden consoles from large TVs (despite the "amnesty" disincentive). DEP is currently arranging a trial collection with a vendor who takes CRTs out of console TVs and replaces them with small dormitory refrigerators (selling the items as a "cocktail bar" for $50 apiece). Goodwill Industries in Springfield is looking at demanufacturing, to further reduce the material sent on the state contract.

There were several advantages to using charities, which were not directly related to markets. By advertising the charity, government can achieve some "win-win" diversion of unrelated materials, such as clothing, shoes and toys. The job training and social programs of the charities are, of course, the main reason they participate in thrift and used goods/asset management processes.

Overall, the most important aspect of the charity system is the "turn-key" nature of the system in Massachusetts. Eight permanent processing facilities (4 Goodwill Industries, 4 Salvation Army) participated in the program, covering ever area of the state except Cape Cod (covered by a Providence, Rhode Island charity). For marketing, this same regionalization created distinct advantages. Very few of the 176 TV repair shops, or computer parts shops, would be willing or able to participate in direct collections from municipalities, much less a statewide program. However, many would be interested in purchasing source-separated items like VCRs or 19" color TVs. The Permanent Regional Facility nature of UMass, Goodwill and Salvation Army offered an important mechanism to cherry-pick items within the asset management paradigm.

6. RESEARCH JOB CONSEQUENCES

Finally, the Electronics Recycling Plan should take a broad view of waste management economics. The method of waste or asset management which preserves the most jobs locally will have a "multiplier effect" in the local economy, raising funds to help run the program. MA DEP was

fortunate to have Dr. Bernie Morzuch of Umass Resource Economics Department take an interest in comparing this research and putting it to use.

ATTACHMENT 2

Chronology of JTR Study

Spring 1998

DEP and UMass OWM use funding provided by the Chelsea Center for Recycling and Economic Development to hire 2 outside consultants. These consultants investigated computer and television recycling markets, resulting in a profile of collection vendors and an analysis of end markets. EPA announces that JTR grant will go to Massachusetts DEP to continue investigation of these markets, and to provide a more scholarly analysis of different market niches.

Massachusetts DEP negotiates a single-payer, bulk-rate CRT recycling contract with an existing vendor. The contract allows a 40% price cut for aggregated materials (1,200 lb. minimum, on pallets).

Massachusetts DEP and University of Massachusetts, Amherst, apply for a research grant through the Chelsea Center for Recycling and Economic Development. The research consultants surveyed 48 electronics asset recovery companies doing business in Massachusetts, and explored CRT glass end markets.

Massachusetts DEP announces a plan to ban CRTs from solid waste landfills beginning in 1999, while easing hazardous waste restrictions on intact, source-separated (commodity) CRTs.

Massachusetts JTR proposal is accepted for funding by EPA.

Summer 1998

DEP provides funding for electronics collections to the Franklin County Solid Waste Management District. FCSWMD held 3 Saturday one-day collection programs at recycling locations in the county. All materials from these collection events were delivered to the University of Massachusetts, Amherst.

Fall 1998

JTR funding begins.

The UMass pilot demonstrates that regional consolidation reduced costs by 40%. Massachusetts contractor (Global Recycling Technologies) leads DEP to open a grant program outside of the original Western Massachusetts / UMass region, expanding the data available for JTR research.

Springfield, Massachusetts Department of Public Works undertakes New England's first curbside CRT recycling program. TVs and monitors are delivered to a trailer at the landfill for recycling. Springfield performs a waste audit of all discarded CRTs (including those set out for trash), which is used by Massachusetts DEP to refine its grant budget estimates.

Winter 1999

UMass signs contract for JTR project.

Surveys drafted of TV repair and export markets by Product Takeback Services and Dillon Associates. Surveys provided to UMass professor Bernard Morzuch for review.

Spring 1999

DEP successfully expands the UMass pilot in "cookie cutter" fashion to six charities. Tonnage increases by 42% per month in the first 6 months of 1999. Six private companies tour UMass and the other collection sites, and several urges DEP to rebid the state contract. All were attracted to the one-stop, loading dock arrangement with charities (compared to hosting one-day drop-offs).

Final results of TV repair survey are provided to UMass Resource Economics Department.

UMass produces detailed inventories of TV types collected and documented demanufacturing time for computers. UMass also tries cost-saving measures, made possible through the leads developed in television repair surveys. Contacts with television repair markets bring one expert to attend a spring pilot collection at UMass. He succeeded in diverting ten percent of residential equipment for positive resale markets. While his positive value of

approximately $1,200 per ton includes his parts and labor, it represents a further reduction of 10% to 50% per ton – a reduction of up to 70% from original cost projections. This TV repairer goes on to win half of the state bid for CRT recycling in Connecticut.

To assist in the research effort, Metech Recycling of Rhode Island voluntarily provides inventory of a one-day collection program.

Summer 1999

A seventh charity joins the collection infrastructure. DEP announces that 3rd party private recycling collectors (e.g. current curbside white goods collectors, computer or TV repairers) will be eligible to deliver under the state grant contract on behalf of municipal grantee clients; this opens the door to more curbside and one-day-drop-off plans.

DEP and JTR consultants tour exporting plants in Rhode Island (Fortune Group) and New Bedford MA (CRT Recycling Inc.) DEP arranges trial collections of sorted monitors and televisions for export, reducing statewide costs for the month by 1/3 in the fall.

Computer repair surveys begin. Site visits to Fortune Group and NE Appliance Recovery Inc.

Through Research International, Cambridge, JTR/DEP jointly fund research of 350 Massachusetts households to ask their attitudes and practices toward TVs and computers which stopped working or which they no longer use. A follow-up expands the survey to 800 households in September. Findings indicate a minority of residents is aware of the charity/reuse collection network.

Morgan Memorial Goodwill Industries in Boston reports results of CRT collection program in Boston, Arlington, and Newton. Sales of TVs through their network of stores greatly increases following the collection period, suggesting that a significant number of CRTs are being successfully diverted. Six of the seven participating charities also reduce recycling bills by selling CPUs for scrap value.

Success: Advanced Electronics of Spencer Massachusetts opens a TV recycling operation, Electronicycle, Inc., and forms partnership with Pennsylvania's Envirocycle Inc. Electronicycle takes over collections from Londonderry NH, Somerville, MA, and some Connecticut towns.

Success: Massachusetts's DEP awards a grant of $45,000 to Global Recycling Technologies to provide in-state *processing of CRTs for glass-to-glass recycling.*

Success: NE Appliance Recovery Inc., a white goods processor based in Freetown, MA, opens a TV and monitor recycling operation, CRT Recycling Inc. and begins trial collections from permanent regional facilities. CRTR develops a new market for heavy, wooden console televisions, creating a value-added item ($50) out of the most expensive to recycle CRT units.

Fall 1999

Results of surveys for Export and Monitor repair are provided by Dillon Associates and Product Takeback Services.

UMass Resource Economics Professor Bernard Morzuch begins processing data from surveys of recyclers, TV repair, and Export companies.

Site visit to Digital Recycling of Worcester MA, an exporter of working and repairable monitors to Russia, Hong Kong, Pakistan, etc.

Trial collections are made for export of repairable monitors and televisions from UMass and two other PRFs. The trial partner (a white goods processor and appliance exporter, CRTR Inc) is not allowed to export CPUs, circuit boards, or monochrome, screen burn, or vacuum damaged CRTs; diversion rate is 60%.

ATTACHMENT 3:

1.0 Television Repair and Monitor Repair Research Product Takeback Services, Billerica, Mass.

The cost of recycling televisions and monitors for raw material value is high ($300 per ton in Massachusetts). Each TV or PC resold or diverted for free can dramatically lower that cost.

Massachusetts JTR consultant focused on the existing television repair industry in Massachusetts and the potential opportunity to develop a program with any of those vendors to repair and reuse the televisions collected by Massachusetts's municipalities. That study had two components: (1) secondary research to understand the impact that HDTV would have on the industry and the waste stream, and (2) a survey of the television repair industry to determine whether an opportunity exists to use any of these vendors as part of a comprehensive repair and reuse program.

1.0 HDTV's impact on the industry – This investigation consisted primarily of secondary research reviewing existing literature on HDTV and its impact on the television repair industry. This research was followed by a small number of direct interviews with people in the television repair industry. This investigation revealed two primary facts: first, that all television broadcasts in the US will switch to HDTV by the year 2006, so that there is a potentiality that all televisions in the US could be converted over to digital in a very short time creating a huge volume of discarded televisions. Secondly, because the new televisions are currently very expensive, the transition will probably be much slower than that. Even though all transmissions will be in digital format, people will be able to buy converter boxes to use with their current televisions and most Cable TV distributors will not convert right away. As a result, several forecasts project only 20% adoption by the year 2006.

Most of the television repair shops surveyed had not yet seen a digital television and had no immediate plans to train for its repair.

1.1 **Television Repair Industry** – The research involved contacting by phone each of the 326 television repair shops listed in the on-line "yellow pages" to obtain an understanding of the current state of the industry in Massachusetts. Of those companies, 174 participated to the survey (see results at http://www.chelseacenter.org/pdfs/TechReport5.pdf). The results of this survey showed that this industry is in deep decline. Most of the respondents were one-person shops with the owners having been in the industry for 30 plus years. Many of these people were planning to retire and leave the business within 5 years.

The general commentary on these interviews was that televisions are becoming a disposable commodity with new sets often selling for under $300, paying $100+ to repair an older television does not make economic sense. This trend has ramifications for both the repair industry as well as the recycling industry. If fewer televisions are being repaired, there will be lower employment in the industry while a larger number of televisions will need to be recycled.

1.2 **Television Refurbishment** - A second portion of the phone survey investigated the possibility of developing a refurbishment/reuse program for the televisions collected by the municipalities.

While 45% of the respondents showed some interest in this program, follow-up questions indicate that most televisions that are older than 7 years old are not worth repairing. While good data on the age of the televisions being collected is not yet available, preliminary indications are that the largest volume of televisions being turned in are older than that cut-off and thus would not justify the program. However, the value of a few repairable units (if 1 in 20 is worth $50) could make a big difference in the average cost of the program.

TABLE C1: SECONDARY RESEARCH: TELEVISION MANUFACTURING AND REPAIR
Bill Waters, Product Takeback Services

Television Repair Industry SIC 7622-02

Included in Commerce Department's "miscellaneous repair services," where earnings in U.S. were $17,108 million in 1997, $16,230 million in 1996, $15,733 million in 1995. (5% growth '96 to '97, 3% growth '95 to '96)

Employment figures (FT equivalent and self-employed): 588,000 in 1997, up from 575K in 1996, and 593K in 1995.
13,079 television repair businesses in the U.S.A., 326 in Massachusetts
296 (91%) of the MA locations have annual sales of less than $500,000
287 (88%) have only one to four employees

The two largest (in revenues):
$5-10 million in sales: Electronic Audio Video in Springfield
$2.5 - 5 million in sales: Nate Lions Service and Parts Center in Fall River

TV repair service offered in conjunction with many other services that span consumer electronics (audio, video), personal computers, home appliances (washer, dryer), and other electronics (multiplexes, PC boards). Some service providers are also retailers. Trend toward "big box" retailing (Circuit City, Good Guys) has created opportunities for small retailers and service providers to stress service.

- Television business was in decline until this year. Philips Consumer Electronics predicts that total industry sales of digital video products will grow from $13 billion in 1998 to $34 billion in 2002.
- 250 million TV's in U.S. homes today. Will be obsolete and replaced or need to be fitted with a digital converter. Replacement market totals $125 billion, according to Bruce Leichtman at Yankee Group.
- LG Electronics (an HDTV manufacturer) signed a contract with Sharp of Japan to provide 2,000 digital TV chip sets that allow analogue TV sets to receive digital signal. (August 1998)
- Many consumers are confused and not aware of options, such as a digital-ready set that can be purchased for less than $2,000. HDTV costs $6,000 and more.
- Consumers will be able to keep watching regular TV until 2006, when analog signals are supposed to be turned off. (Experts think this date will slip.) Even if analog is shut off, current TV sets will work with cable.
- Digital TV will be available in every home in the U.S. by May 2002, says government.
- Yankee Group predicts only 2.5% of U.S. households will have HDTV by 2002.
- When Color TV was introduced in early 1950's, it took 8 years to penetrate 10% of the market.
- Flat-panel, hang on the wall plasma screens now cost $15,000 to $25,000, just for the screen. They are expected to be the most popular TV screens of the future. Format (called "progressive" scanning) used to create picture for plasma screen is used on modern computer monitors and most medical imaging displays.
- "Interlace" scanning is used on current television sets. HDTV has more than one scanning standard. Some networks will broadcast in "interlace," while others will use "progressive." Consumers may use PC's to receive their television, using an advanced version of the "progressive" standard. (i.e. Web/TV)
- Merging of audio, visual, computing has vast implications for service businesses. Lots of knowledge required and many vendors with whom to interface.

Additional Sources of Information on the Web:

www.electronix.com (repair world), www.cemacity.org (Consumer Electronics Manufacturers Association)
http://plop.phys.cwru.edu/repairfaq/REPAIR

The PTS study determined that while the advent of HDTV could potentially have a huge impact on the volume of televisions in the waste stream, indications are that the shift will be much more gradual on televisions which were sold in the late 1990s. Nevertheless, even with a gradual transition, there will be a reduction in repairs and a spike in the number of televisions being disposed of. All of these televisions will have to be recycled under the new Massachusetts waste ban unless another market can be found to export them or to reuse them in the US.

Based upon volume, ours survey shows there is only a small opportunity to reuse the televisions collected by Massachusetts' municipalities as the typical age of the disposed of television exceeds the age deemed repairable by the repair shops. While the average age of the returned televisions may go down as people switch over to HDTV, there is no certainty that people will be interested in buying the older technology at that time. However, even a 10% repair rate would dramatically reduce the $300 per ton cost of television recycling now paid by the state. Therefore this opportunity should continue to be pursued as the Massachusetts' recycling programs progress.

Using TV repair as a method of reducing and adding higher value to the collection program was tried at the UMass one-day collection events in the Spring of 1998. Advanced Electronics, Inc., of Spencer MA, attended the event and diverted an estimated 20% of units brought in to the facility. The value added to (salvaged from) these collections is provided in the UMass Report.

2.0 Computer Repair Survey

During the summer of 1999, a final study was begun by PTS paralleling the one performed earlier on TV repair. This survey was directed at all of the Computer Service and Repair companies listed on-line, and like the first study was intended to determine whether there might be an opportunity to refurbish the computer monitors collected by the municipalities and reuse or resell them.

2.1 Survey of the Computer Repair Industry – This investigation was focused on contacting all of the companies listed on-line under the category of Computer Repair and Services. However, given the limited time available for the project, only a small subset of the companies was actually contacted. However, even with this limited sample, a few conclusions could be drawn. First, this industry is healthier than the television repair industry and is growing. Secondly, computer monitor repair is a specialty and most computer repair companies do not do their own monitor repair, but prefer to forward the business to other companies that specialize in monitors. Finally, as in the television repair industry, most companies are finding that with the low cost of new monitors today it is technically possible to repair an old monitor, but that the monitor may not be resellable in the current strong economy. This is particularly true with the smaller monitors that can now be purchased new for around $100.

As with the television survey one objective of the project was to determine whether some of these companies might be interested in working with the state to refurbish some of the monitors that are collected by the municipalities. The response to this question was mixed. While several companies were interested in working with the state, the general feeling was that the type of monitors likely to be collected (smaller 14" and 15" monitors), was not going to be cost effective to

repair here in the US. A handful of these companies seemed to think that they could make a refurbishment program work for them.

Conclusion

Given the small amount of time spent on this project, it is hard to draw any firm conclusions. However, it does appear that there is a potential to work with some companies in this industry to refurbish and reuse electronics collected in Massachusetts. While there may be only a dozen companies that have monitor repair capability and are also interested in this low-end business, these companies should be sufficient to run a test program. If this program develops and is successful, more companies may take an interest in participating long term.

The survey and secondary research indicate that monitor repair potential exceeds its practice due to the high standards of American buyers and the high cost of technician labor. A good indicator of repairability of all types of televisions and monitors can be found from the Samuel M. Goldwasser website, www.repairfaq.org.

TABLE C2: FEASIBILITY OF MARKET REPAIR

Copyright Samuel M. Goldwasser, www.repairfaq.org

2.12) *Most Common Problems*

The following probably account for 95% or more of the common monitor ailments:

* Intermittent changes in color, brightness, size, or position - bad connections inside the monitor or at the cable connection to the computer or video source.

* Ghosts, shadows, or streaks adjacent to vertical edges in the picture - problems with input signal termination including use of cable extensions, excessively long cables, cheap or improperly made video cables, improper daisy chaining of monitors, or problems in the video source or monitor circuitry.

* Magnetization of CRT causing color blotches or other color or distortion problems - locate and eliminate sources of magnetic fields if relevant and degauss the CRT.

* Electromagnetic Interference (EMI) - nearby equipment (including and especially other monitors), power lines, or electrical wiring behind walls, may produce electromagnetic fields strong enough to cause noticeable wiggling, rippling, or other effects. Relocate the monitor or offending equipment. Shielding is difficult and expensive.

* Wiring transmitted interference - noisy AC power possibly due to other equipment using electric motors (e.g., vacuum cleaners), lamp dimmers or motor speed controls (shop tools), fluorescent lamps, and other high power devices, may result in a variety of effects. The source is likely local - in your house - but could be several miles away. Symptoms might include bars of noise moving up or down the screen or diagonally. The effects may be barely visible as a couple of jiggling scan lines or be broad bars of salt and pepper noise, snow, or distorted video. Plugging the monitor into another outlet or the use of a line filter may help. If possible, replace or repair the offending device.

* Monitor not locking on one or more video scan ranges - settings of video adapter are incorrect. Use software setup program to set these. This could also be a fault in the video source or monitor dealing with the sync signals.

* Adjustments needed for background brightness or focus - aging CRT reduces brightness. Other components may affect focus. Easy internal (or sometimes external) adjustments.

* Dead monitor due to power supply problems - very often the causes are simple such as bad connections, blown fuse or other component.

Attachment 4: Export Markets **Summary Report Prepared by Patricia Dillon**

This report summarizes the results of a survey of potential export markets for used computers, used televisions, and electronic scrap. This survey was intended to provide a glimpse at the nature of the export market to assess the viability and desirability of exporting used equipment from Massachusetts' emerging collection infrastructure.

The report also identifies potential export vendors, and the equipment they accept for export. These equipment specifications provide a "first cut" at matching the Massachusetts used electronics stream with potential vendors. More accurate assessments of the export potential of equipment collected in Massachusetts will come from trial shipments sent to export companies. "Hands on" assessments or equipment sorts will provide additional insights on the potential for equipment diversion to resale markets based on age and condition of equipment and pricing.

The Survey

The search for potential exporters of used electronic equipment yielded 95 companies. The search encompassed a variety of sources, including published export/import directories, Internet searches, telephone directories, and networking with companies in the industry. Of these potential export candidates, time permitted contact with sixty-seven companies, resulting in thirty-two completed interviews.[1] Fourteen of these companies are currently engaged in the export business.

Exporters of Used Electronics: Who Are They?

Companies involved in the export of used electronic equipment are diverse, not unlike the domestic market for electronics recycling. Export companies may specialize in resale of used electronics or scrap recycling; may export a broad range of goods or only electronics; may be brokers or actual equipment processors; and may deal exclusively with exports or a combination of US sales or processing and exports. Table 1 summarizes the export activities of the companies surveyed.

A variety of companies provide access to export markets, for example:

- US-based or foreign used equipment brokers;
- US companies with processing facilities overseas; and
- US-based electronic and appliance recyclers with direct or indirect export connections;

US-based electronic recyclers are included in this list because they may utilize export markets for selected material streams or products (e.g., resalable items), depending on the company policy and customer requirements.

1 About one-third of the non-respondents were no longer in business.

Some general observations of the industry, extracted from the surveys, are outlined below. Caution should be taken in interpreting these findings, given the limited sample size. Further research is needed to validate these "hypotheses".

- Export companies tend to specialize in either equipment resale or scrap recycling, similar to their US counterparts.
- Televisions and computer equipment are handled by different companies. Most of the companies handling computer and scrap electronics, for example, are reluctant to handle televisions. Televisions are considered to have "little value" due to low metals content.
- Televisions were destined for resale markets in Central and South American, while computer equipment for resale or material recycling was headed to Asian countries. One possible reason for this is the existing infrastructures in these regions. China, for example, has established a metal recycling infrastructure based on foreign imports as a means to secure base materials for manufacturing industries. Three of the companies interviewed have Chinese metal processing facilities, licensed by the government, that exclusively import scrap almost entirely (over 90%) from the US. In comparison, televisions have traditionally fallen into the "appliance" category. Televisions may be headed south as part of the used appliance industry.
- The final destination of equipment sold to exporters was often not known, with the exception of export companies operating their own processing facilities overseas.

Table D1: Summary of Export Surveys

Company	Type of Business/ Service	Export/Import Business[1]	Destination	Annual US Export Volume	Employment
Advantage Computer Exchange (Georgia)	US used computer broker	Does not routinely export	Not applicable	Not applicable	No information
Allied Computer Brokers (MA)	US electronics recycler	Some equipment to overseas reuse markets through 3rd party US company	China Taiwan	Approx. 10% of equipment processed	15 employees, plus temporary labor
Alternative Exports (Florida)	Exporter	New & refurbished computer equipment; currently no used equipment exports	South & Central America, Caribbean		No information
CMC International (MA)	Exporter/broker	Electronics and other goods	Asia	~100 containers (electronics)	US 1.5 employees
CRT Recycling Inc. (MA)	US recycler - appliances and electronics	Appliances & computer monitors	China (monitors)	No information	US 11 employees
Corona Vision (Texas)	US monitor and computer repair	Monitors and computers through third party vendors; business shifted from majority exports to repair and recycle	Taiwan Japan Canada	No information	Variable

Fortune Group (RI/China)	US corporation exporting to Chinese subsidiary; some US processing	Electronics, telecommunications scrap, wire & cable	China	40 million lbs/year	US ~100 China ~ 200
Kaytron Systems (MA)	Computer equipment and parts resale, serving computer maintenance service companies	No export	Not applicable	Not applicable	No information
Lotus International (Michigan)	Manufacturer and exporter of CRTs, monitors and other electronics	New cathode ray tubes, monitors and other electronics; no used equipment	Worldwide	No information	No information
Maharajha Metal Industries (India)	Indian metal processor	Import electronic scrap	India	No information	No information
National Christina Foundation	International non-profit organization	Distributes used computer systems world-wide	Worldwide	No information	No information
Odyssey Systems (Texas)	Used equipment broker with US and overseas markets	Computer hardware, monitors	Asia	No information	No
Quality Cable & Electronics Inc. (Florida)	Exporter of cable TV equipment	Mostly cable TV equipment; some TVs	Latin America	No information	No information
SES Ltd. (Canada)	Used equipment broker, working with 5-10 exporters	Computers, office and medical equipment	Canada	Not available	No information
Sunrise Appliance (Florida)	US appliance dealer - new and used equipment	Variety of goods, incl. televisions, appliances, surplus inventory; sold direct to retail stores	South and Central America	Varies	No information
Ta Tsen Trading Inc. (Illinois/China)	US corporation exporting to 2 company-owned facilities in China	Metals, electronic scrap 100% exports	China	~20 million lbs/ Annually (All exports)	US 20 employees China 250 employees
Tung Tai Trading Corp. (California/China)	Non-ferrous metal recycling, exports to 7 company-owned facilities in China	Metal, electronic scrap 100% exports	China	~40 million lbs/yr	US 6 employees China 2,000 empl.
Wasan International Co. Ltd. (New Zealand)	Used computer broker	Used computers & peripherals	New Zealand	No information	No information
Wo Sang Metal Shop Co. Ltd. (Hong Kong)	Hong Kong company with scrap yards in Los Angeles	Metals, electronic scrap	China	No information	No information

1 Used equipment or scrap unless "new" equipment is specified.

Overview of Overseas Market Opportunities

Type of Equipment

One goal of the export surveys was to identify potential markets for reutilization of computer equipment and televisions deemed "obsolete" by US standards. This survey found export markets available for the following equipment:

- Color VGA and SVGA computer monitors, 14" or greater;
- Central Processing Units (CPU) with 486 or better microprocessor;2
- Color televisions in working condition, and
- Electronic scrap (including 286 and 386 CPUs).

In addition, one exporter would consider taking large quantities of 386 units for markets in Europe.

These markets are not static. Available export markets will evolve as technology evolves. Several exporters, for example, said that they currently accept 486 computers, but this may change soon. The market for 486s is getting "weak". As more and more used Pentium's come on the second-hand market, there is less demand for 486 units, even in less developed countries.

Access to export markets and pricing may also depend on whether the equipment is in "guaranteed" working condition and volume. For example, some exporters only deal with large quantities of like items; others require a minimum of a container load (for example, ~40,000 pounds of electronic scrap). Table 2 provides company-specific details, including the type of equipment accepted, specifications, and minimum quantities.

Table D2: Equipment Specifications & Processing by Export/Import Company

Company	Used Equipment		Processing	
	Specifications	Min. Volume	US	Overseas
Allied Computer Brokers (MA)	Export through 3rd party • CPUs for resale: 486 or better for recycle: 386 or less • Monitors VGA & SVGA color; no black & white; working or non-working	Container (35,000- 40,000 lbs); mixed loads accepted	Sort	Resale (~20% or 1 of 5 units) and scrap recycling
Alternative Exports (Florida)	Not in used equipment business, but willing to find customers if send inventory of used computer equipment	Not applicable	Not applicable	Not applicable
CMC International (MA)	• CPUs for resale: 486, Pentiums; itemized inventory; must	40,000 lbs; mixed loads accepted	Sort as needed. Load containers.	Does not own processing facilities. Independent import

2 There might be opportunities to export 386 computer systems through the donation program of the National Christina Foundation, although they mostly accept 486 units. The Foundation links donors and recipients. The donor organization usually pays for transportation, either directly or through grants.

	guarantee working condition • Monitors for resale: min. 14"; mostly SVGA, some VGA; working condition; only equipment coming out of service (i.e., not stored) • Misc. electronic scrap • No televisions	Can provide warehouse capacity until fill container.		company checks if equipment is working, and does minor repairs. Electronic scrap processed for precious metals recovery.
CRT Recycling Inc. (MA)	Export to third party in China: • Monitors >1992, no screen burn	Min. 40,000 lbs		3rd party rebuilds about 95% of monitors. Guarantees zero landfill
Fortune Group (RI/China)	• Computers • Monitors • Peripherals, • Printed wire boards • Mainframes	Mixed loads accepted	Scrap recycling, including CRT glass and plastic recycling	<10% resale/reuse. Manual dismantling, sort & material recycling, including 12 grades of plastics, CRT glass, precious metals. CRT glass used in bottles containing chemicals for industrial use
Lotus International (Michigan)	Not in used equipment business; if large volumes could seek out potential markets using their overseas network; need detailed inventory of regularly available equipment.	Not applicable	Not applicable	Not applicable
Maharajha Metal Industries (India)	• Electronic scrap, including computer, telephone, cellular phone, PC board, telecommunications	No information	No information.	No information
National Christina Foundation	• Computer systems & peripherals 486, Pentium, possibly 386	Varies	None	~92% reused as is, repaired, or parts. Repair, if needed, done by recipient organization.
Odyssey Systems (Texas)	• SVGA, working monitors ($13/unit) • VGA & SVGA monitors, untested, no screen burn ($3/unit) • CPUs 486, low end Pentium possibly large quantities of 386s • No televisions	20-40' container (or 1000-1100 monitors per 40' container)	None. Sold to third party overseas.	Third party sells to repair facilities overseas.
Quality Cable & Electronics Inc. (Florida)	• Televisions color; min. 19"; must guarantee working condition; mixed brands accepted as long as similar in design; buys pre-1993	50 TVs or more per shipment	No processing	
SES Ltd. (Canada)	• CPUs >486 • Monitors min. 14" color SVGA • Copiers	No information	No processing. 95% resale as is, mostly in Canada	Resale

	• Medical equipment Send equipment inventory to assess resalability			
Sunrise Appliance (Florida)	• Televisions min. 19"; working condition; large volumes, like types; "newer the better" but does buy 1988/89 vintage (typically deal with hotels that pull out large volumes of older, but working TVs)	40' container (approx. 6-700 20" televisions)	No processing.	Sold directly to retail stores.
Ta Tsen Trading Inc. (Illinois/China)	• CPUs for resale: 486, Pentium; not cannibalized • Monitors for resale: min. 14"; SVGA, some VGA brands; no screen burn • Misc. electronic scrap • Printers, keyboards, mainframes • No televisions	40' container (approx. 40,000 lbs); mixed loads accepted	Load/reload containers. No processing.	Processed at company-owned facilities. Resale as is, some repair. Manual disassembly for material recycling, including precious metals refining, and CRT glass and plastics recycling. Claim zero landfill.
Tung Tai Trading Corp. (California/China)	• Electronic scrap • No televisions	40' container	None. Warehouse in San Jose, CA.	Mostly material recycling. Manual disassembly and sort waste streams; recover precious metals; sell segregated plastics; CRT glass to lead smelters and road aggregate.
Wasan International Co. Ltd. (New Zealand)	• CPUs Pentium 166 or better • Monitors • Notebooks • Hard drives (min. 540MB) • CD Roms • Floppy drives (min. 1.44MB)	No information	No information	No information
Wo Sang Metal Shop Co. Ltd. (Hong Kong)	• Used computers & monitors	No information	Operate scrap yards in Los Angeles	Used computers and monitors shipped to China for reuse. (No further details.)

Pricing information was available from some companies, as summarized in Table 3. Pricing is highly dependent on several factors, including configuration, age, and volume, so these figures should just be used as "ballpark" estimates.

Table D3: Sample Export Pricing

Equipment	Price Range (US dollars)
Central Processing Unit (CPU) • . 486	 $4.00 - 12.00/ unit

• Pentium	$20.00 - 50.00/ unit
Monitors Depending on conditions, VGA or SVGA	$2.00 - 13.00/ unit
Electronic scrap	$0 - .15/ pound
Televisions (working condition) • >1993, 19" color • older 19" color	 $30 - 40/ unit $10 - 20/ unit

4. Advantages and Disadvantages of Exporting

Exporting has its advantages and disadvantages as summarized in Table 3. While exporting used equipment gains access to lower labor costs and markets hungry for technology, the downside is the potential "unknown". Equipment that is exported for resale is often sold to brokers or other processors, and the chain of ownership is difficult to trace. Export companies themselves don't always seem to know where the equipment goes. In many cases, pricing drives the export decision. One indication of "reuse" is if an export company pays a "per unit" price for equipment, rather than a per pound price. That said, it remains difficult to determine is the fate of the unusable equipment. It is for this reason that some electronics recyclers and US electronics firms have policies prohibiting export of used equipment. Other companies will access export markets, but only after a thorough review of operations.

Table D4: Summary of Advantages and Disadvantages of Exporting Used Electronics

Advantages	Disadvantages
• Access lower cost labor for labor intensive processes such as repair • Access to markets with higher tolerances for older technologies	• Exact destination of material sometimes unknown • "Guarantee" of equipment disposition not always available • Distance limits oversight of equipment processing • Long-term viability of market

As a final test of the export market, Massachusetts DEP ran several on-line classified ads offering working and non-working monitors and televisions for resale in other countries. Based upon responses to these ads, MA DEP has determined that monitors and televisions are more likely to be exported for repair than for scrap. The price per unit as well as the strict standards against monochrome, screen burn, plastic housing damage, and glass damage would not make sense if the ultimate use of the material was for scrap rather than for repair.

ATTACHMENT 5

MADEP Survey of Massachusetts Households Electronic Equipment and Household Chemicals Disposal Conducted by Reports International Cambridge.

I. Objectives and Methodology

A) Objectives of the Study

- Understand the current methods consumers use to dispose of cathode ray tubes (CRT's) by discarding unwanted or broken TV's and personal computers.
- Highlight the existence of opportunities for communicating disposal alternatives to the public.
- Determine influences upon disposal practices, including demographic characteristics such as age and education.
- Assess consumer awareness and understanding of High Definition Television (HDTV or DTV) to measure general expectations for future TV disposal.
- Understand current methods of discarding household appliances and electronic equipment in general, including items such as refrigerators or stereo equipment.

B) Survey design and methodology

Method:	Computer-Assisted Telephone Interviewing
Interviewing dates:	June 14-17, 1999
Sample size:	Representative sample of 450 Massachusetts residents
Margin of error: level	±4.6 percentage points at the midpoint of the 95% confidence

II. Executive Summary

One-third (32%) of all respondents have had a TV in their household that stopped working within the past five years. Nearly four in ten (37%) of these residents report that they *threw the TV away* (approximately 275,000 TV's), while one-fifth (20%) say they *put the TV in storage* (approximately 148,000 TV's). Older respondents (56 years of age and over), as well as those with a high school education or less, appear slightly more likely to *throw their TV away* than younger respondents and those with higher levels of education. In addition, virtually all of those who *placed a TV in storage* owned their own home. However, sample sizes among subgroups of the population are often small (less than 30 respondents) throughout this report, and it is necessary to use caution when interpreting these results.

A majority (60%) of Massachusetts's residents report having a personal computer in their home. Four in ten (40%) of those who have a computer say that they have had a computer in their home that stopped working (approximately 548,000 computers). Most of those who stopped using a computer for any reason other than because it was broken either *gave the computer to someone else* (39%) or *put it in storage* (33%; approximately 160,000 computers). Very few respondents report *throwing the computer away.*

The vast majority (79%) or respondents report a willingness to pay a small fee to *deposit a TV or computer at a designated disposal site.*

Three in ten (31%) respondents report a general awareness of *charities that accept TV's and electronic equipment*, with college graduates and those 36-to-55 years of age expressing the greatest levels of awareness. Still, one in seven (14%) of those who express awareness of such charities *cannot cite any by*

name. Those who donated electronic equipment to charity most frequently say they donated a *computer* (15%) or *TV* (13%). Upper-income respondents ($50,000 or more) are nearly twice as likely to report donating an item as those who earn less income.

Half (53%) of respondents have had an appliance or piece of electronic equipment professionally repaired, with residents most often stating that they had a *washer/dryer* (25%) repaired, followed by a *TV* (13%). In contrast, only 15% sold an item through a yard sale or classified advertisement.

Three out of five (60%) of respondents are aware of HDTV, with men, college graduates, and upper-income respondents possessing the highest levels of awareness. One-fourth (25%) of respondents say HDTV will provide a *better quality picture.* However, one-fifth (19%) of those who are generally aware of HDTV *do not recall anything specific about it.*

Half (46%) of respondents have disposed of household chemicals. Those 36 years of age and older are more likely than younger respondents to report disposing of chemicals (53% vs. 32%), and they are twice as likely to express awareness of the proper method for disposing of such chemicals (61% vs. 29%). Those 36 years of age and older are thus more likely than younger respondents to report disposing of the chemicals at a *disposal site* (71% vs. 28%). Conversely, younger respondents (under 36 years of age) are more likely to report disposing of them *with the household trash* (39% vs. 13%).

III. Consumer Disposal of CRT Units

Understanding current CRT disposal practices among Massachusetts's residents provides an indication of the magnitude of CRT disposal in the state, as well as the types of disposal methods residents most frequently employ. In addition, such an understanding can help suggest possible areas for effectively communicating CRT disposal alternatives to consumers, including disposing of TV's and computers at designated CRT disposal sites. Consequently, this survey asked respondents how many TV's and computer monitors they possess, as well as how they dispose of TV's and computers in their possession that are either obsolete or that no longer work. The research paid particular attention to why residents *throw these items away*, rather than either *having them repaired* or *donating them to charity*. In addition, the survey assessed consumer receptiveness to *paying a small fee to properly dispose of TV's and computers* they no longer want.

Disposal of TV's

- Half (55%) of all respondents report having either one (22%) or two (33%) TV's in their household. Meanwhile, one-fourth (23%) have three TV's, and one in ten (11%) report having four TV's in their home. A lesser number possess either five (5%) or more than five (4%) TV's.

  ⇒ Therefore, based upon these percentages, Massachusetts's households contain and estimated 5.8 million TV's (see Table 1).

  ⇒ The average number of TV's per household is 2.5.

Table 1. Estimated Number of TV's in Massachusetts Households

Number of TV's in Household	*% of Respondents*	*Number of Households* (% respondents X 2,322,000)*	*Number of TV's* (of TV's in household x number of households)^
One	22	510,840	510,840
Two	33	766,260	1,532,520
Three	23	534,060	1,602,180
Four	11	255,420	1,021,680
Five	5	116,100	580,500
More than five	4	92,880	557,280
Total Number of TV's			5,805,000

*Figure (2,322,000) represents the *1996 U.S. Census* estimate of the total number of households in Massachusetts.

^All those reporting more than five TV's in their household were counted as having six TV's.

- One-third (32%) of all respondents report that they have had a TV in their household that stopped working within the past five years (approximately 740,000 computers).

- Among this group, nearly four in ten (37%) disposed of their TV by *throwing it away* (12% of all respondents, or approximately 275,000 TV's).

  ⇒ Half (55%) of those who disposed of their TV by throwing it away say they did not have it repaired because *repairs cost too much.* In addition, one-third (32%) of those who threw their TV away maintain that it *could not be repaired.* Other reasons residents who disposed of their TV by throwing it away cite for not having it repaired include the TV was *not worth having repaired* and having it repaired was simply *too much trouble.*

⇒

Respondents 56 years of age and older are more likely to say they *threw the TV away* than are younger respondents (45% vs. 33%). Similarly, those possessing a high school education or less are more likely to report *throwing their TV away* than are those with more than a high school education (46% vs. 34%). However, since sample sizes among those who threw their TV away are small, it is necessary to use caution when interpreting these results.

- One-fifth (21%) of those who had a TV in their home that stopped working had it *professionally repaired*, and a nearly identical number (20%) *put the TV in storage* (6% of all respondents, or approximately 148,000 TV's). A lesser number (9%) *gave the TV to someone else*.

Figure 1. Possession of TV's that Stopped Working

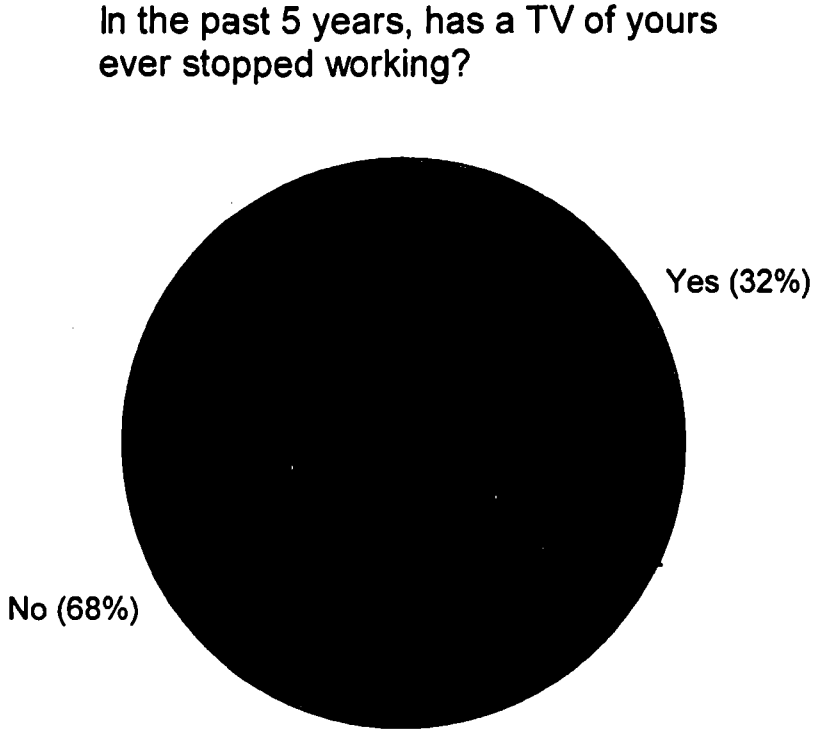
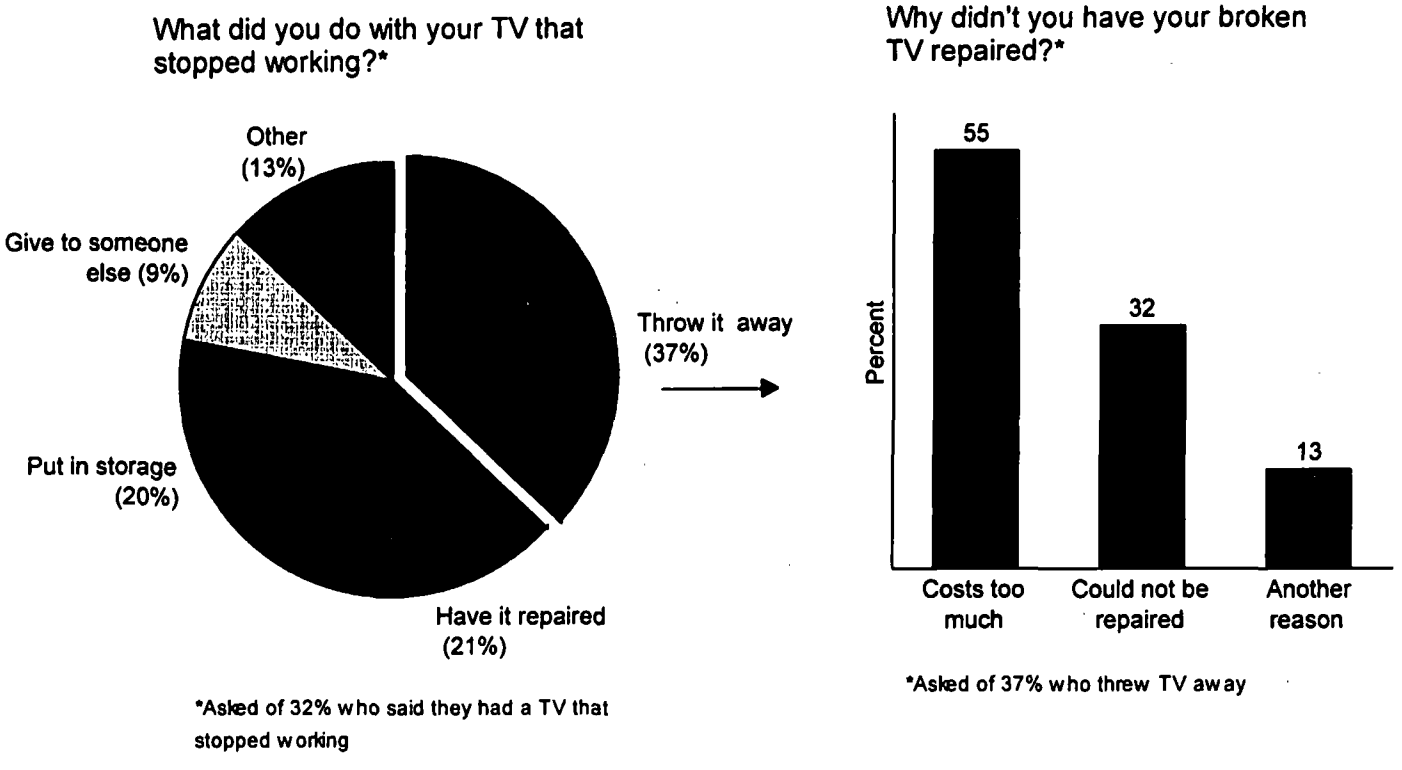


Figure 2. Disposal of TV's that Stopped Working



Disposal of Computers

- Three out of five (59%) respondents report that they have a personal computer in their home (approximately 1.4 million Massachusetts households).

  ⇒ As expected, upper-income respondents (83%) and college graduates (76%) are more likely to have a personal computer in their home than are lower-income respondents and those who possess less than a college education.

- Two-thirds (67%) of those who have a computer in their home possess just one computer. A far lesser number of respondents report having two (18%), three (10%), or more than three (4%) computers in their home.

  ⇒ Consequently, based upon these findings, Massachusetts's households possess an estimated total of approximately 2 million computers (see Table 2).

Table 2. Estimated Number of Computers in Massachusetts Households

Number of Computers in Household	***% of Respondents****	***Number of Households*** (% respondents X 1,369,980)**	***Number of Computers*** (Number of computers in household X number of households)
One	67	917,886	917,886
Two	18	246,596	493,192
Three	10	136,998	410,994
More than three	4	54,799	219,196
Total Number of Computers			**2,041,268**

*Figures represent percentages of the 59% of all respondents who say they have a computer in their home.

**The figure (1,369,980) represents the total number of households that report having a computer, calculated as 59% of *1996 U.S. Census* estimate of the total number of households in Massachusetts (2,322,000).

^All those reporting more than three computers in their household were counted as having four computers.

- Two in five (40%) of those who own a computer report that they have had a computer in their home that they stopped using (approximately 548,000 computers).

  ⇒ Upper-income respondents (50%), as well as those with a graduate or professional education (70%), are more likely have a computer in their home that they stopped using than are those who report lower income and education levels.

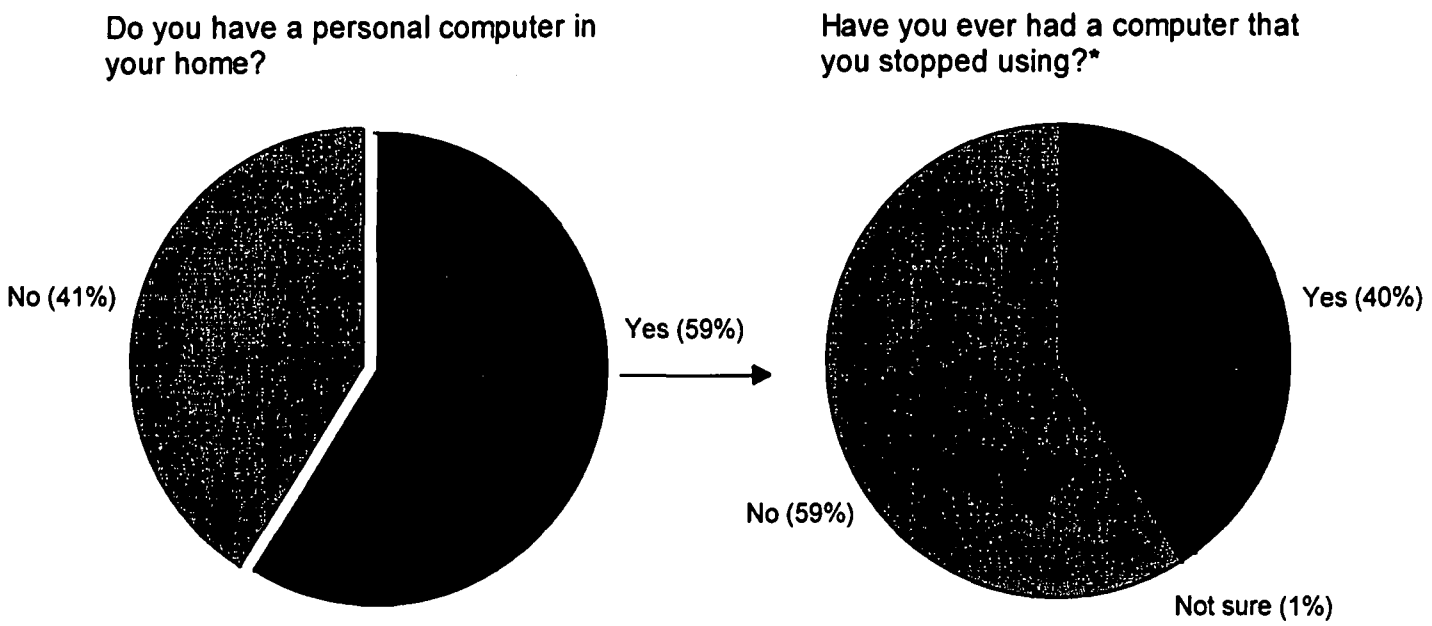
- Half (47%) of those who stopped using a computer say they did so because they *upgraded to a new computer.* Fewer report that they stopped using a computer because it was *too old* (22%), or *too slow* (13%). Only one in ten stopped using a computer because *it was broken* (11%).*

  ⇒ Respondents who stopped using a computer for any reason other than because it was broken (e. g. upgraded, too old) most often say they either *gave the computer to someone else* (39%) or *put it in storage* (33%; approximately 160,000 computers). A lesser number either *donated the computer to charity* (12%) or *sold it* (7%).

- Regardless of whether the computer they stopped using was broken or not, less than one percent say they threw their computer away (a total of four respondents).

* The number of respondents who stopped using a computer because it was either too slow or broken is small (less than 15 respondents). Thus, it is necessary to use caution when interpreting results based upon this group of respondents.

Figure 3. Ownership of Computers and Percent with Computers that Stopped Working



*Asked of 59% who said yes

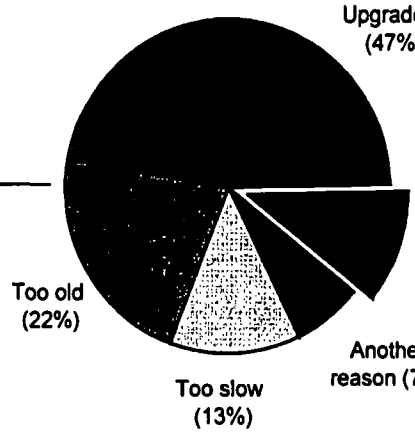
Figure 4. Why Respondents Stopped Using Computers

What did you do with the computer you stopped using?*

Give to someone else	39%
Put in storage	33%
Donate to charity	12%
Something else	8%
Sell it	7%

*Asked of 89% who say the computer was not broken

Why did you stop using this computer?*



*Asked of 40% who said they had a computer that stopped working

What did you do with your broken computer?*

Throw it away	25%
Donate to charity	17%
Repair it (self / professionally)	16%
Put in storage	8%
Sell it	8%
Give to someone else	8%

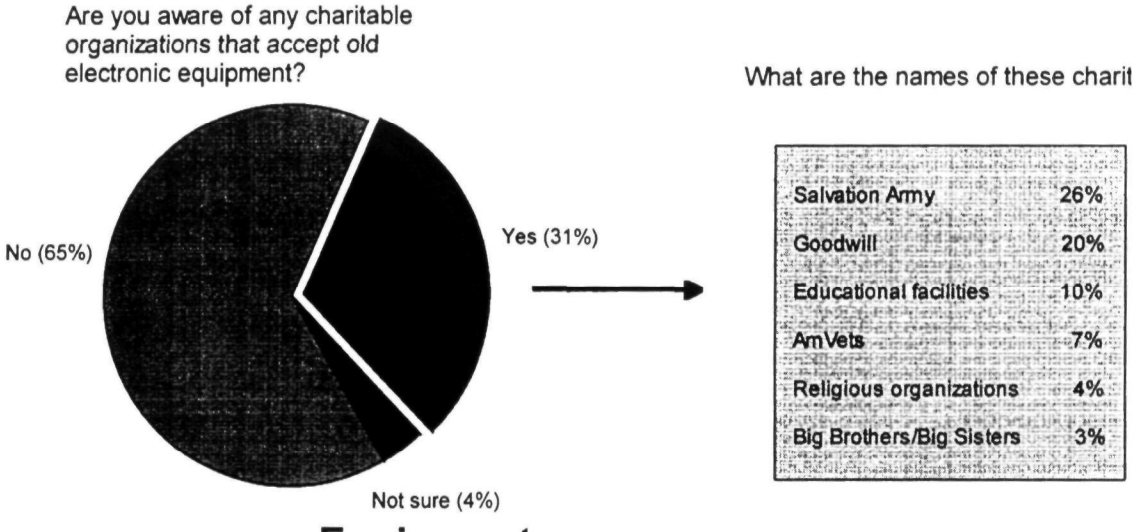
*Asked of the 11% who said the computer was broken

Awareness of Charities that Accept Electronic Equipment

- Three in ten (31%) of all respondents report a general awareness of charities that accept TV's and computers. The charities respondents most frequently mention are the *Salvation Army* (26%), *Goodwill* (20%), and *educational facilities* (10%). However, one out of seven (14%) of those who say they are aware of such charities *could not name any.*

  ⇒ College graduates are slightly more likely to express awareness of charities that accept electronic equipment than are those with less than a college education (34% vs. 26%). In addition, those 36-to-55 years of age possess a greater awareness of such charities (43%) than do both older (26%) and younger (26%) respondents.

Figure 5. Awareness of Charities that Accept Electronic Equipment

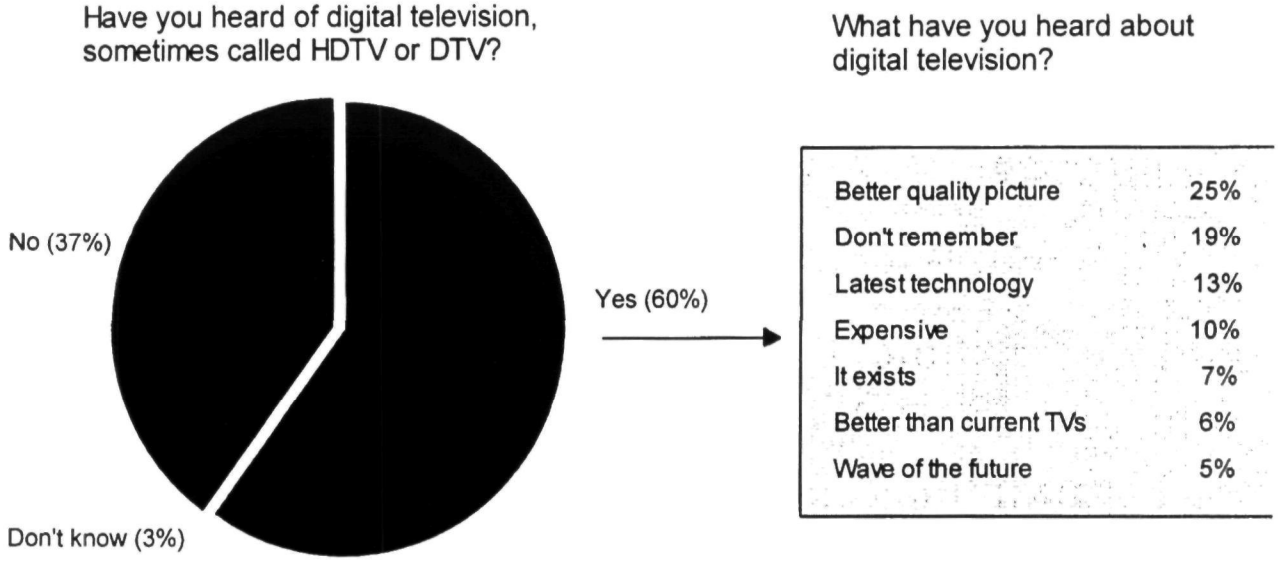


Awareness of HDTV or DTV

- Three out of five (60%) residents have heard of digital television. Respondents most often say that HDTV will provide a *better quality picture*

(25%), that they *don't remember* anything specific about HDTV (19%), and that it is the *latest technology* (13%). Men, college graduates, and upper-income respondents report the highest levels of awareness of HDTV.

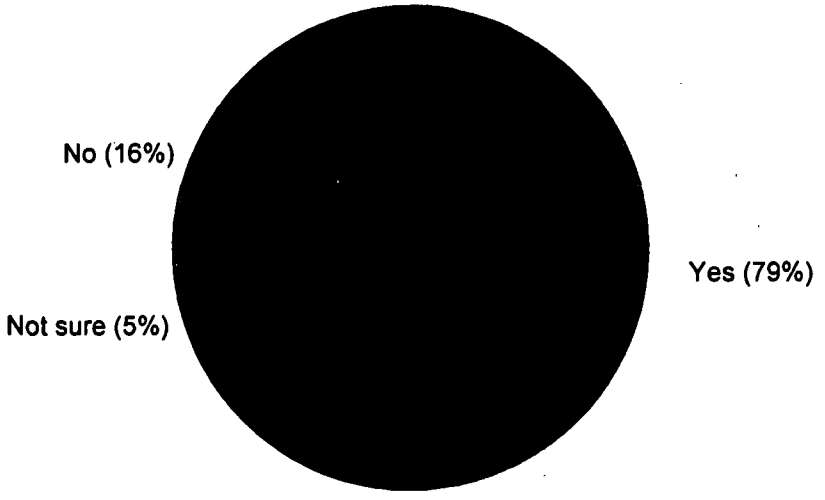
Figure 6. Awareness of HDTV



Willingness to Pay a Small Fee to Deposit TV's and Computers

- The vast majority (79%) of respondents report a willingness to pay a small fee to deposit a TV or computer that they no longer want at a designated disposal site. Consumer receptiveness to the idea of paying a small fee for disposing of CRT's cuts across differing income, education, and age groups. However, residents living in the state's 617 area code are the least receptive to this idea (65% vs. 80% or more in all other area codes in the state).

Figure 7. Willingness to Pay Fee for Disposing of TV's and Computers



IV. Consumer Disposal of General Appliances and Electronic Equipment

In addition to focusing specifically upon the disposal of TV's and computers, understanding how residents dispose of broken or unwanted household appliances and electronic equipment in general can help provide a clearer picture of broad disposal practices in the state. This research focused upon three ways residents might discard broken or unwanted items: *donating the items to charity*, *having the items professionally repaired*, and *selling the items through yard sales or classified advertisements*.

Donations to Charity

- Three in ten (31%) respondents report having donated an appliance or other piece of electronic equipment to charity, while two-thirds (67%) have never made such a donation.

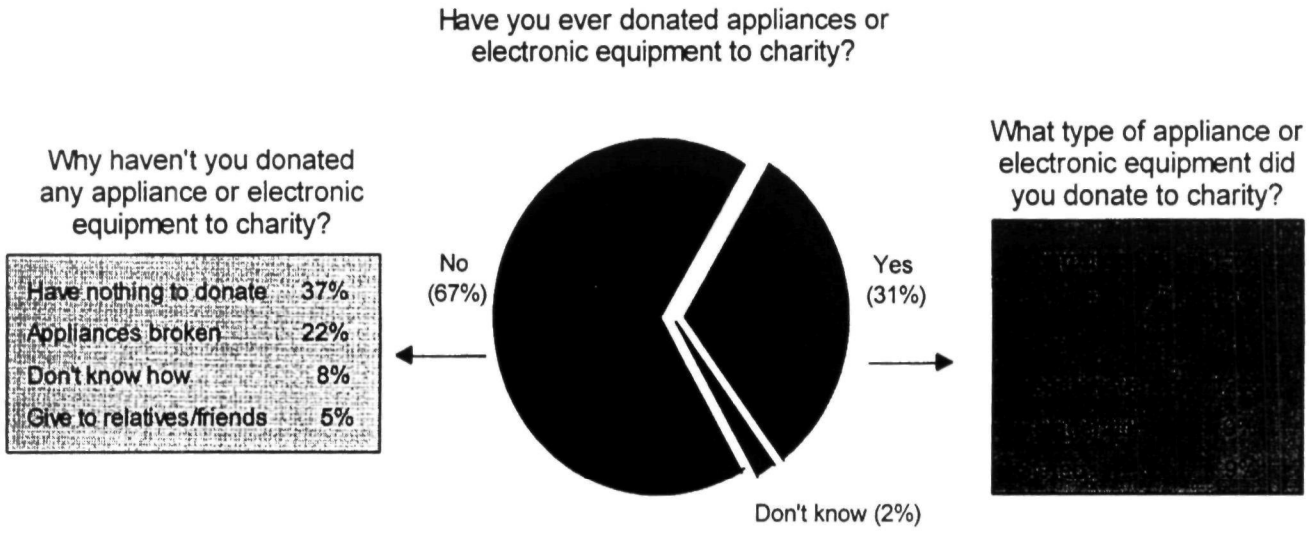
- Among those who have made a donation, residents most frequently report donating to charity include computers (15%), TV's (13%), refrigerators (9%), and stereo equipment (9%). Fewer respondents mention items such as a washer or dryer (6%), or a stove (5%).

  ⇒ Those who have not donated an appliance to charity most often say they *never had anything to donate* (37%) or the *appliance was broken* (22%).

- Three out of five (63%) respondents most recently donated an item to charity within the last year. One-fourth (23%) donated an item one-to-three years ago, while one in ten (12%) donated an item to charity more than three years ago.

- Two in five (41%) upper-income residents ($50,000 or more) say they recently donated an item to charity, compared with one-fourth (23%) of those in the middle-income category ($35,000 to $49,999) and a similar number (26%) of those earning less than $35,000 a year.

Figure 8. Donations to Charity



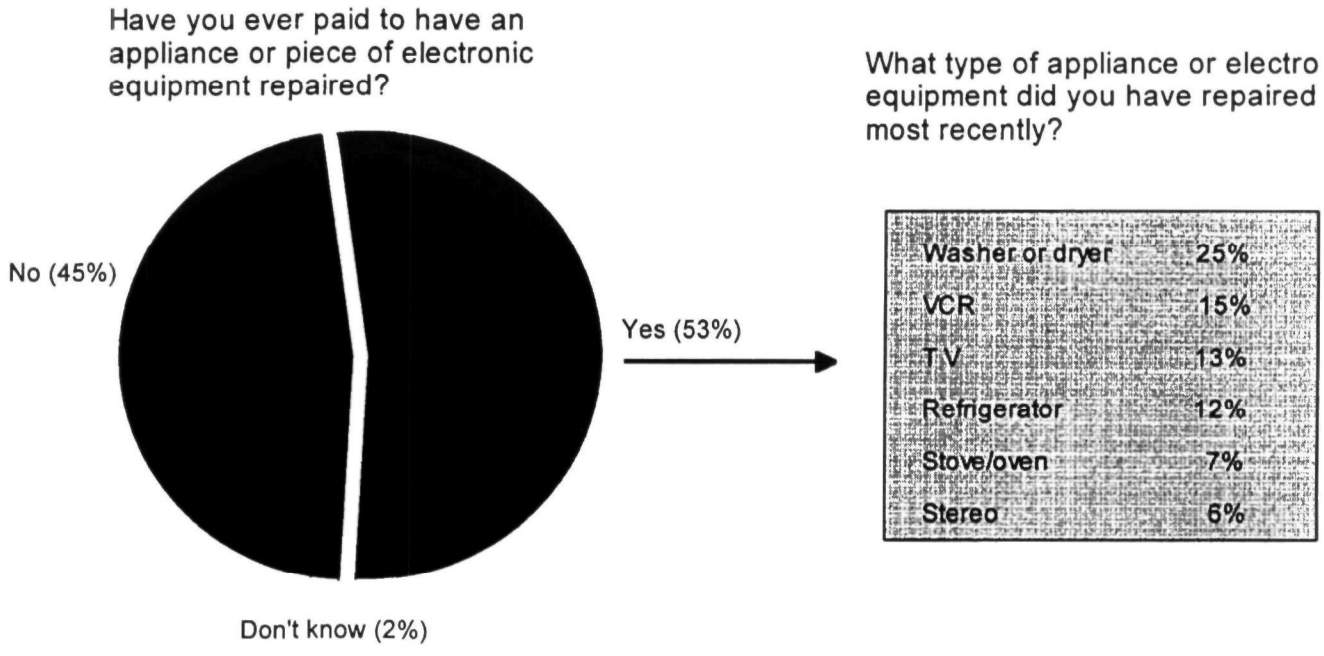
Professional Repairs

- Half of all respondents (53%) say they have *paid to have an appliance or piece of electronic equipment repaired.*

  ⇒ Among this group, one-fourth (25%) recently had either a washer or a dryer repaired, while fewer respondents mention a VCR (15%), TV (13%), or refrigerator (12%).

  ⇒ Half (48%) of all respondents had the item repaired within the past year. Three in ten (29%) had the item repaired one-to-three years ago, and 20% had the item repaired more than three years ago.

Figure 9. Professional Repairs



Sales through Yard sales or Classified Advertisements

- Only one in seven (15%) respondents state that they recently *sold an appliance or piece of electronic equipment through a yard sale or a classified ad*, with respondents most frequently citing that they sold stereo equipment (21%), followed by a TV (12%) or washer/dryer (9%).

  ⇒ Four in ten (40%) respondents who have sold an appliance or piece of electronic equipment did so within the past year. Three in ten (29%) report selling the item within the past one-to-three years, and a similar number (28%) sold the piece of equipment more than three years ago.

  ⇒ The primary reason residents cite for <u>not</u> selling anything through a yard sale or classified ad is that they simply *did not have anything to sell* (41%). In addition, respondents mention that they did not have *anything worth selling* (18%) and that selling items in this fashion is *too much of a hassle* (7%).

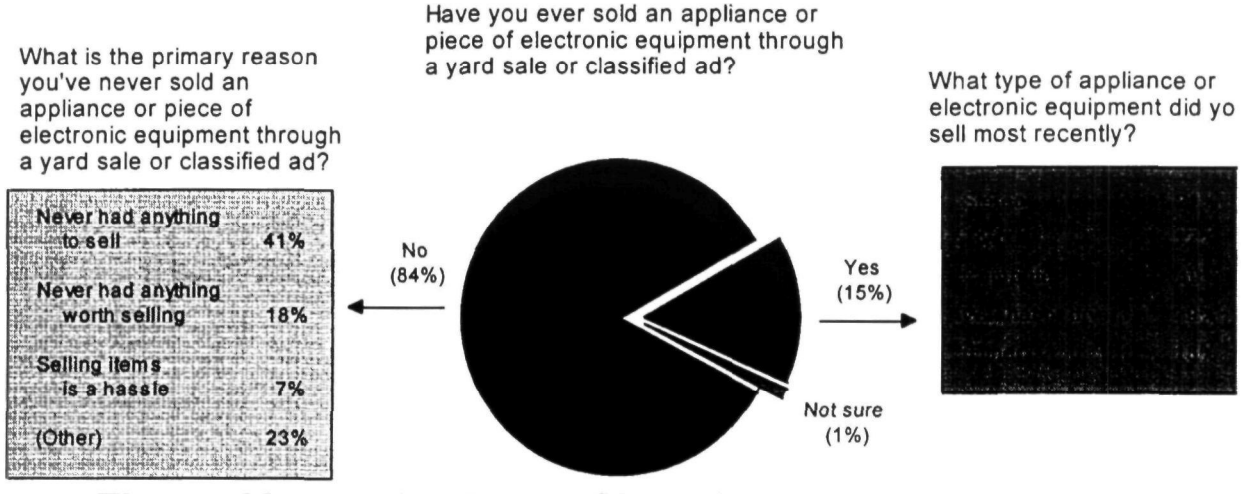


Figure 10. Yard sales or Classified Ads

V. Consumer Disposal of Household Chemicals

Along with appliances and electronic equipment, this survey asked respondents whether or not they have ever disposed of household chemicals, such as paint or cleaners. The research focused upon *how residents dispose of these materials*, as well as what respondents believe is the *proper method for disposing of this type of household chemicals.*

- Half (46%) of all residents have disposed of partially used household chemicals at some time. Four in ten (38%) of these respondents disposed of chemicals in conjunction with cleaning out a storage area, while somewhat fewer did so during a move (21%) or some other type of household project (18%).

  ⇒ Residents 36 years of age and older are far more likely than younger respondents to have disposed of household chemicals (53% vs. 32%). In addition, men are more likely than women to report disposing of household chemicals (51% vs. 43%).

- Further, the longer respondents have lived in their current home, the more likely they are to dispose of household chemicals. Half (51%) of those who have lived in their current home for more than four years report disposing of household chemicals at some time.

  ⇒ Conversely, only one third (35%) of those who have lived in their home two-to-three years, and an identical number (35%) of those who have lived in their home one year or less, say they have disposed of such materials.

- A strong majority (65%) of those who have disposed of household chemicals say they took them to a *hazardous waste drop-off site*. Nevertheless, two in ten (19%) say they disposed of the chemicals by *throwing them away in the household trash* (8% of all respondents).

  ⇒ Respondents 36 years of age and older are far more likely than younger residents to report disposing of household chemicals at a *hazardous materials drop-off site* (71% vs. 28%).

  ⇒ In contrast, younger respondents (35 years of age and younger) are more likely to say they deposited the chemicals in the *household trash* (39% vs. 13%).

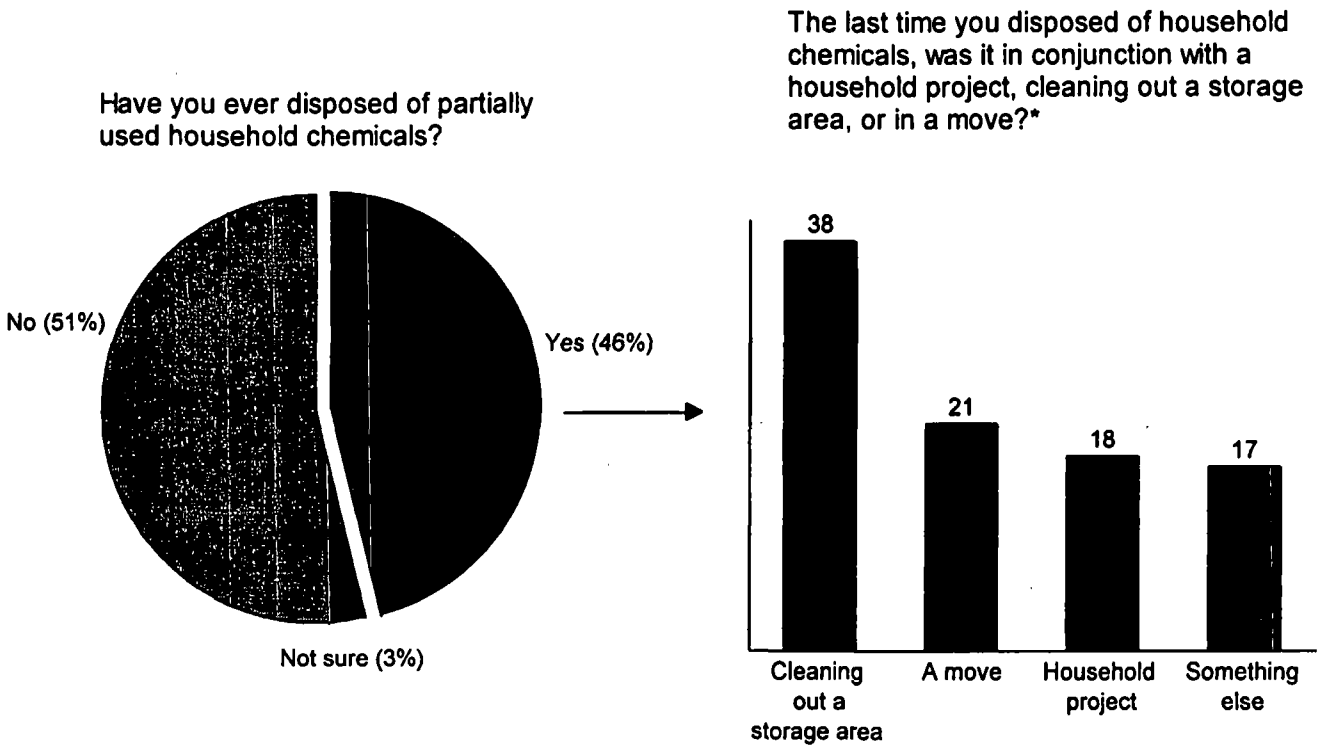
- Half (54%) of all respondents are aware that the proper method for disposing of household chemicals is to *take them to a hazardous waste drop-off site*.

  ⇒ Still, one-third (36%) report that they *don't know* the proper method for disposing of such chemicals, while a much smaller number (5%) believe the proper method is to *throw the chemicals out with the household trash*.

- Older respondents (36 years of age and older) are more likely than younger respondents to express awareness that the proper method for disposing of household chemicals is to *take them to a hazardous materials drop-off site* (61% vs. 29%).

- Further, respondents with a graduate or professional education display the highest level of awareness of the proper method for disposing of household chemicals (72%). Meanwhile, high school graduates (48%) and college graduates who did not attend graduate or professional school (52%) exhibit similar levels of awareness of the proper way to dispose of hazardous household chemicals.

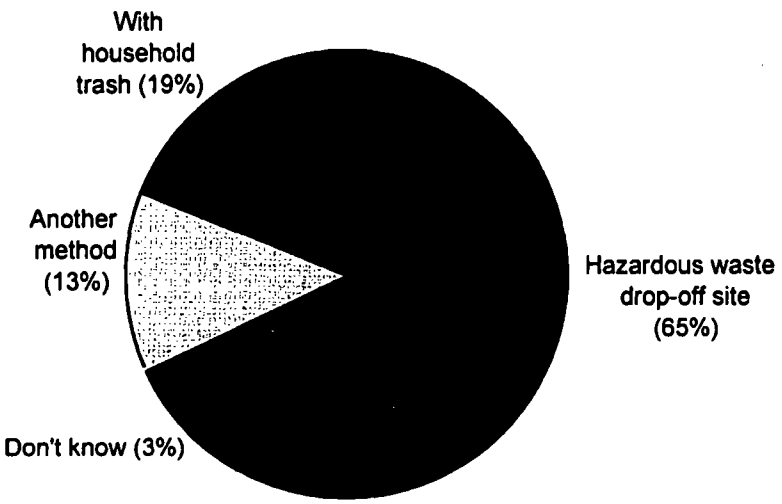
Figure 11. Disposal of Household Chemicals



*Asked of 46% who have disposed of chemicals

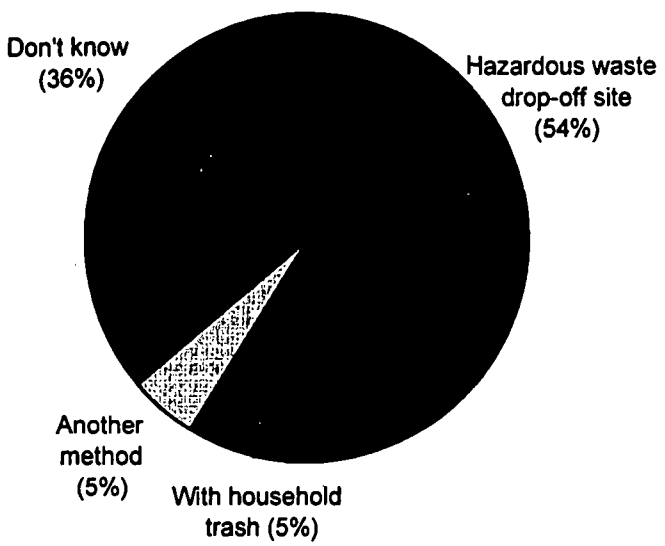
Figure 12. How Consumers Dispose of Chemicals and Awareness of Proper Disposal Method

How did you dispose of household chemicals?*



*Asked of 46% of residents that have disposed of household chemicals

As far as you know, what is the proper way to dispose of household chemicals



ATTACHMENT 6

Massachusetts DEP Technical Assistance Grant
Franklin County Solid Waste Management District
Consumer Electronics Collection
October 1998

Introduction

The Franklin County Solid Waste Management District serves 21 towns in western Massachusetts with a total population of 64,000. The District received a technical assistance grant from DEP to conduct a pilot consumer electronics collection in order to determine the type and volume of electronics being stored in residences.

Jan Ameen, District Program Director, spent several months researching the issue of CRTs, attending a national conference on electronics, and meeting with DEP officials and other agencies to discuss the recent hazardous waste rule change and implementation of electronics collections.

The District scheduled a one day, 6 hour long collection for consumer electronics on Saturday, September 19th at three sites: Shelburne DPW garage, Greenfield DPW garage, and the Erving DPW garage. In an agreement with DEP, the electronics would be shipped, without disposal costs, to the University of Massachusetts- Amherst Intermediate Processing Facility (IPF) where they would be quantified and demanufactured or sent for demanufacturing.

The District expected to receive 4-5 tons of electronics, but instead received 12 tons. Of the 12 tons, approximately 9 tons were from residents and 3 tons from schools. Equipment came in from 192 residents and 6 schools. Residents came from twenty-three different towns in Franklin County. At each site 2 or 3 residents had chosen to drive over 30 minutes from their town of residence to the collection site. Of the 1,200 pieces of equipment collected there were approximately 165 CPUs, 200 monitors, 180 televisions, 140 keyboards, 86 printers, 80 stereos, and 70 VCRs.

Collection Logistics

After selecting the date of September 19, Jan contacted the Shelburne, Greenfield, and Erving DPWs to gain permission to use their sites for the collection. These sites were chosen for their geographic location: Shelburne would serve "West County" towns, Greenfield would serve a large central county population, and Erving would serve the "East County" towns. Each site had access to a telephone, bathroom, and most importantly, cover. It was important to the District to keep the electronics secure and dry over the weekend until they were shipped to UMass the following week.

Advertising began for the collection soon after the sites were chosen. Prior to publishing a list of acceptable materials, Jan checked with DEP and UMass for appropriate specifications. She did not want to collect items, which could be classified as scrap metal, such as toasters and fans, or items that had little demanufacturing value, such as hair dryers and humidifiers. A copy of the final advertisement is attached. The aim of the District was to collect electronics, which would either fall into the CRT ban (monitors and TVs) or could contain heavy metals, such as items with circuit boards.

The District heavily advertised the event, with almost half of the total expense for the collection going to display ads. Half-page ads ran in five area newspapers over a two-week period immediately preceding the collection for a total of ten ads. The ad listed the date, sites, and times for the collection. The District decided to open each site for two hours to minimize the number of volunteers and staff needed to operate each site. The ad also listed what was and wasn't acceptable. Press releases were sent to newspapers, radios, and local cable stations.

There were several large articles in the daily newspapers regarding electronics prior the collection. DEP held a press conference at UMass to announce the electronics-related grants. This received good media coverage. The media also picked up the District's press releases and ran several large, prominent articles on the collection. These are attached.

In the two weeks prior the collection, Jan began calling freight and moving companies in an attempt to locate a company to move the electronics from the sites to UMass. All of the collections were held on ground level and thus needed a pallet jack and hydraulic lift gate to move the electronics from the ground to the floor of a truck. Jan called 5 freight companies and 6 moving companies. None of them were able or interested in moving the electronics. Two days before the collection, Jan learned that Ryder truck rents trucks with hydraulic lift gates. The District rented a 24-foot box truck from Ryder for this purpose.

A component whose importance was originally overlooked was the need for a forklift truck or bucket loader with forks at each site. Greenfield had an electric forklift, Erving had a bucket loader with forks, but Shelburne had neither. This was a major set back at the Shelburne site.

The District was originally going to pack the electronics in gaylord boxes, but after talking with the UMass IPF, it was decided to stack the equipment on pallets and wrap the pallets with stretch film. The pallets were attained at no cost and the stretch film was purchased through a state contract with Grainger.

Collection Process

Pallets and stretch film were delivered to each site on the Friday preceding the collection. All pallets were placed indoors. Four or five volunteers were present at each site. Traffic cones were laid out to direct traffic in a one-way direction to the unloading area.

As vehicles arrived, a volunteer would conduct a brief survey with the resident. The number, type, and age of each piece of equipment were recorded as well as the town of residence. The items were then unloaded and stacked on the pallets. All CRTs (monitors and TVs) were stacked together. All other equipment (VCRs, printers, stereos, CPUs) was stacked together. When the stack was approximately 4 feet high, it was wrapped in stretch film.

There were several items, which had to be turned away, such as electronic drum sets, humidifiers, fans, cameras, etc. We accepted some items, which may not have a high demanufacturing value, such as baby monitors, satellite receivers, and typewriters. We lacked the appropriate information to know what "extras" to accept and made the best decisions possible on the spot. While it is impossible to list every electronic item in a "do and don't" scenario, there may be general recommendations, such as our "circuit board" specification.

There were several businesses, which participated although we were focusing on households. Several schools also participated. Most of the schools had very large quantities of equipment. See the attached site statistics.

The Shelburne site was very steady with 65 residents coming in the two hours. We estimate that we collected 3 tons of electronics in Shelburne. The Greenfield site was rather chaotic and hectic with a long line of cars stretching across the parking lot out to the street. We had 107 residents plus two large loads from Greenfield Community College. We unloaded six cars at once for most of the time. The Erving site was exceptionally slow with only 25 residents participating. This may have been due to the hours of operation (2-4 pm) or the location which some people had difficulty finding.

The most time-consuming aspect of this project was the four trips in two days that it took to load and unload the electronics from each site to UMass. This was a difficult and tiring process, especially in Shelburne, which didn't have a forklift. After several attempts using the bucket loader without forks, we were fortunate to have a forklift from a nearby orchard come and assist us.

On the following Monday and Tuesday, the equipment was loaded into the rental truck and driven to the UMass IPF. We were weighed in on their scale; both loaded and tare. We were able to back up to a loading dock where a fork truck could drive into the truck to unload the pallets. The equipment was to be quantified by UMass at a later date.

Observations/Recommendations

1) We were woefully unprepared for the volume that we received. We were short by almost 10 pallets overall and had to leave items on the floor to pack on Monday. Be prepared for the worse and then some.

2) It is difficult and nearly impossible to exclude businesses. We didn't specifically advertise for them or exclude them. When they arrived we accepted their materials. We believe that they will find a way to bring their equipment, even if excluded. Typically, businesses bring in their "waste" disguised as a household - either by using their personal vehicle or making several trips.

3) We knew of several schools that were going to participate but we didn't know the volume they were bringing. GCC brought in two stake body trucks of computers! We don't believe this to be the exception with schools. Many schools have technology grants or technology coordinators who are cleaning out old computers and replacing them with new ones.

4) We were asked by several individuals at the collection sites if they could "scavenge" some units or parts. In most cases, they were denied this request due to the impossibility of knowing which monitors/keyboards/CPUs/TVs worked and which didn't work. It is easy to understand why they would make this request. In Greenfield, there were 27 pallets stacked 4'-5' high with electronics, some looking relatively new. It's overwhelming to see so many "products" destined for disposal. Incorporating a "reuse" area into a collection is an option to be explored.

5) It is imperative to have the right equipment to move the full pallets (average weight 680 lbs.) from the ground up to truck level. And even with the right equipment, this process is labor and time intensive. Using a facility with access to a loading dock would have reduced the time it took to load the truck. A town could "free load" the equipment, basically loose onto a truck and then palletize or box it at the trailer or IPF.

6) We chose to keep the equipment dry, although this was not a requirement from UMass. We have been informed that keeping the equipment dry facilitates remanufacturing versus demanufacturing of wet equipment. Follow the specifications of your contractor.

Queries

The following questions arose after the collection event and after discussing the pilot collection with other solid waste managers. The District began asking itself and others these questions and hopes to locate solid answers or data prior to undertaking additional electronics collections. These questions have been posed to various individuals in the field and conflicting information has been given. There are many experts and their responses must be seriously considered and evaluated. The task ahead is determining what course is best for solid waste managers to take.

1) We collected a variety of electronics, including non-CRTs, to gauge the type and volume of "electronics" being stored. However, since the collection we are beginning to question the environmental hazards associated with all types of electronics. What should and shouldn't we collect and why? We have been told that electronics can have lead, mercury switches, capacitors, and lithium batteries. All of those components can be considered toxic, but what is the environmental danger associated with them as part of electronic equipment?

Of the 1200 units we collected, 2/3 or 800 units were non-CRT electronics. A pilot in San Jose, CA had similar percentages of CRTs to non-CRTs. Should non-CRTs be collected for their "resale value?" Or is there an environmental risk associated with disposal of non-CRTs? Can it be quantified? Can we assume the risk is associated with all brands of a type of electronic equipment? For example, do all microwave ovens have mercury switches, etc.?

On the other hand, what shouldn't be collected because it's not an environmental risk and it has no re-sale value? We collected 140 keyboards, which we recently learned have no hazardous constituents. Keyboards don't take up a lot of space on a pallet, but are they "worth" collecting?

Similar to the evolution of household hazardous waste collections, we believe that managers will soon have to come up to speed about the types of electronics, which pose environmental risks and those that do not. Again, like HHW, it does not make fiscal sense to pay a high cost per ton for a material, which can be handled, as solid waste.

2) We have been told that monochrome CRTs do not have lead. We don't believe the new regulations distinguish between leaded CRTs and unleaded CRTs. Should we collect monochrome or unleaded CRTs? Are there other hazards associated with them?

3) We asked DEP about broken CRTs and how they will be handled. DEP believes that broken CRTs will be rare and are included as "intact" unless completely crushed. However, we know from experience that over time people bring in unimaginable material - regardless of the advertising specs. How, then, should that one CRT run over and crushed by the garbage truck be handled?

4) We were recently asked whether we had "depressurized" the CRTs we collected. We didn't. This question caught us by surprise, as we have no information suggesting CRTs should be depressurized to prevent implosion. This obviously raises the questions: should we? shouldn't we? and why or why not?

The questions posed above represent a myriad of questions we are asking ourselves and being asked by others. Electronics are an "unknown" recyclable. There is a very steep learning curve facing Massachusetts's solid waste managers in the coming months. There already exists a great deal of information on electronics collections and we hope that DEP will assist us as we decipher and digest it.

Consumer Electronics Collection: Franklin County Solid Waste Management District

SHELBURNE SITE - 9 - 11 am

64 participants from 11 towns; 2 businesses; no schools; 309 items; average 4 units/ household; average age is 14 years old; estimate 3 tons total.

ITEM	Households
CPUs	49
monitors	58
keyboards	38
printers	37
fax machine	1
VCRs	15

TVs	59
telephones	7
answering machines	4
radios	9
stereos	22
Other: modem, intercom, disk drive, baby	8

monitor, CD player, copy machine, satellite receiver	

The two businesses brought in 18 CPUs, 19 keyboards, 19 monitors, and 6 printers.

GREENFIELD SITE - 11:30 - 1:30

107 residents from 13 towns; 3? businesses; 4 schools; 750+ items; residents average 3.5 units each; average age for residential electronics is 15 years old; estimate 8 tons total.

ITEM	House-holds
CPUs	99
monitors	132
keyboards	93
printers	43
fax machine	0
VCRs	56

TVs	110
telephones	11
answering machines	9
radios	20
stereos	54
hard drives	21
circuit boards	30

Other: floppy drives, power supply, camera, typewriter, voltage regulator, tape drive, tape player, modems, cable box, projector	25

Businesses brought in 12 CPUs, 7 monitors, 5 keyboards, 2 printers, and 3 telephones.
Greenfield Community College brought in 31 CPUs, 54 monitors, 50 keyboards, 10 printers, 10 VCRs, 19 TVs, 12 telephones, 5 radios/stereos
Other schools brought in approximately 25 CPUs, 25 monitors, 30 keyboards, 1 VCR, 4 TVs, and 7 hard drives.

ERVING SITE: 2-4 pm
ERVING SITE: 25 residents from 10 towns; no businesses; 2 schools; 116 items; average 2.6 units per resident; average age is 12 years old; estimate 1 ton total.

ITEM	Households
CPUs	15
Monitors	10
Keyboards	7
Printers	6
fax machine	0
VCRs	1
TVs	12
telephones	0
answering machines	0
radios	5
stereos	5
Other:	0

The schools brought in 14 CPUs, 18 monitors, 13 keyboards, and 6 printers.

shelburne

TOWN	# participants
Ashfield	3
Buckland	10
Charlemont	3

Colrain	5
Conway	4
Deerfield	1
Hawley	1
Heath	1

Northfield	1
Shelburne	32
Whately	1

greenfield

TOWN	# participants
Athol	1
Bernardston	4
Buckland	1
Deerfield	4
Gill	4
Greenfield	65
Leyden	4
Montague	16
Northfield	2
Shelburne	1
Shutesbury	1
Sunderland	2
Whately	1

erving

TOWN	# participants
Bernardston	1
Charlemont	1
Colrain	1
Deerfield	1
Erving	3
Gill	2
Montague	9
New Salem	1
Northfield	3
Orange	3

Expenses Incurred for Franklin County Consumer Electronics Grant

Labor 154 hours @ $20/hour	$3080	
Labor 28 hours @ $15/hour	$ 420	
Administrative Overhead		$2262
Travel expenses		$ 223
Advertising (5 local newspapers; 10 ads total)	$2780	
Stretch film		$ 156
Ryder truck transport to UMass		$ 309
Misc. (food, photos)		$ 70
Mailing to towns/ schools		$ 30
Electronics Conference		$ 505
TOTAL		$9835

Expenses directly associated with collection event (4 weeks planning)

75 hours @ $20/hour		$1500
Labor 28 hours @ $15/hour	$ 420	
Administrative Overhead		$ 750
Travel expenses		$ 70
Advertising (5 local newspapers; 10 ads total)	$2780	
Stretch film		$ 156
Ryder truck transport to UMass		$ 309
Misc. (food, photos)		$ 70
Mailing to towns/ schools		$ 30
TOTAL		$6085

H: Attachments

Attachment 7:

University of Massachusetts Office of Waste Management
Electronics Grant Report
October 28, 1999

Introduction

The University of Massachusetts Office of Waste Management has been involved in electronics recycling since 1992. A brand new 18,000 square foot facility was opened called the Intermediate Processing Facility that provided the space to start collecting scrapped electronic equipment from campus. The OWM's experience in electronics recycling, a large storage facility, and convenient location for residents of western Massachusetts made it an optimal site for starting the state's electronics recycling program.

The years of collection, sorting, and demanufacturing, combined with the new experiences of municipal material collection has taught some valuable lessons. The following is a list of events, tasks, and projects run by OWM under this grant period:

- Kick-off press conference Sept 20, 1998
- 12 tons accepted from FCSWMD one day collection
- 2 one day drop off events hosted at IPF
- Development of MS Access Database of scrap electronics vendors
- Study of brown goods- age and time efficiency
- Over 10,000 items received, inventoried, and shipped for recycling
- Equipment sent to Advanced Electronics to assess reparability and possible resale of various electronics
- Monitors sent to CRT Recycling for export test
- Continuous scheduling of municipal loads
- Public Relations/media time
- Serve as information source to people around the country interested in electronics recycling

One necessity for an electronics collection program is the space to store material. As with all recyclables, there has to be enough volume collected to make recycling work. This year, approximately 140 tons of electronic material moved through our facility taking up at least 1/3 of the building at any given time. The IPF also has about a 400 square foot area designated to demanufacturing. This area includes a worktable equipped with a variety of hand tools as well as an air drill, workspace for 3-4 people and several gaylord boxes for the demanufactured components.

Before the grant period, all material went through the demanufacturing process and the broken down components were individually bid on for recycling. Generally, bald CRT's went to one vendor while the other components went to scrap/precious metal vendors. With electronics recycling gaining popularity in the region, vendors are increasingly willing to take whole electronic equipment. For the past 18 months or so, the OWM has been sending most electronics intact to its vendors. The little demanufactured equipment leaving the facility has been due to demanufacturing tests preformed for

the DEP or broken down parts brought it by our the customers. The intact method of recycling is by far preferred to demanufacturing for a few reasons. Even though students provide a relatively inexpensive labor force, OWM cost studies have shown computer demanufacturing to be about a break-even operation and when brown goods are added, there is a clear loss. The reduced handling and elimination of a demanufacturing staff make sending intact electronics the best option from a cost and facility management standpoint.

Daily Operation

Current day-to-day operation of the electronics-recycling program is running relatively smoothly. The OWM is collecting scrap electronics from the various campus entities and separating them into two categories: CRT bearing items and non-CRT items. Local municipalities and businesses call in advance and make an appointment to bring material to the IPF. Towns that have a DEP Market Services Grant are eligible to drop material off for free, all others including businesses are charged $5 per CRT item. Individual residents are encouraged to contact their DPW or town recycling coordinator for electronics recycling. When the material arrives, the driver helps IPF staff unload and separate into the same categories as mentioned above.

This system generally works well, but there have been some glitches that are still a challenge at times. The inception of the IPF as a regional collection center drew a great deal of attention. Before the announcement of this opportunity, no one knew what type of response to expect. Almost immediately after, there was an overwhelming response. There were businesses, private residents, schools, municipal offices, and various recycling professionals with questions and service requests for the OWM. Some were arriving unannounced, expecting to recycle their unwanted electronics. Clear and consistent communication with these customers has been essential to this program running smoothly. There were several emergency or short notice staff meetings to decide on unanticipated problems for the first several months of operation. One of the biggest challenges has been the varied interpretation of OWM rules, media coverage reports, and DEP guidelines under the municipal grant contracts. The DEP had a multi-angled approach to electronics recycling which included the use of this facility, trailers at landfills, curbside collections, Goodwill and Salvation Army collections, and direct dealings between municipalities and the state's vendor. To further confuse residents and businesses, municipal and regional recycling coordinators/waste managers sometimes conveyed conflicting information to the media and residents. A meeting of the DEP representative, OWM staff, and recycling coordinators was very helpful in getting all the major players on the same page. Following this meeting, there was less confusion on who is allowed free access to recycling, and proper procedure to get materials to the IPF.

With consistent communication established, there were other challenges with some customers. Some people did not understand the need for an appointment. This was especially true of the places like the 5 colleges, the town of Amherst, and local businesses who were accustomed to being able to use our facility for a variety of recycling needs, on short or no notice. A 24 hour advanced notice is required for a variety of reasons. Firstly, the main function of the IPF and OWM is not the electronics program. Therefore, a major condition of the grant was the OWM's right to refuse service to outside entities for any reason necessary to preserve normal operation. In addition, we found that the facility can fill-up very quickly and there have been occasions where service has been refused due to a lack of space in the facility. Well-scheduled drop-off appointments also assure that staffing is available for inventory

and unloading shipments. Again, clear communication and firm appointments have helped minimize these types of problems.

Upon congregating enough material for a truckload, either the CRT or scrap metal vendors are called respectively to pick up from the facility. The items going to the CRT recycler are generally TV's or computer monitors but they will take any CRT containing item. Global Recycling Technologies, the current CRT recycler has been providing good service until recently when they are taking several weeks to respond to a call for a pick-up. The scrap vendor has been very flexible in allowing a variety of materials to be sent to them. OWM has made a conscientious effort at keeping a minimum of contamination in the loads (we take out excessive plastic, junk electronics or trash and bare metal). Special items like large copiers, plotters, scientific equipment, or other odd ball unknown materials have all been OK thus far.

Inventory

Part of the OWM's responsibilities as recipients of the grant was to inventory the materials collected. Information on where material comes from, when it arrived, brand names, date of manufacture, and special information specific to the type of equipment helps to characterize the electronics waste stream. The results of this study will be useful to the DEP and the OWM in planning, marketing to vendors, and managing material.

The inventory process is extremely time consuming. The initial basic inventory increased unloading man-time by approximately 25%. An extra person was required to record information as equipment is unloaded from each truck. Students and the project coordinator then spent almost 200 hours to enter this information into an MS Excel spreadsheet. When a more detailed inventory was taken to assess specific information from each piece, the trucks were unloaded to the facility floor and set aside for inventory. Recording the date of manufacture, screen size or speed of CPU's, model number, and other notes required about two minutes per item. The equipment was then ready to be separated into the appropriate boxes for recycling. Over two thousand items were inventoried in this way and then entered into an MS Excel spreadsheet. The process was very time consuming and was the cause of disorganization and a general mess within the facility. It is recommended that OWM data be used rather than repeating such an endeavor by another group in the future. A detailed report on the results of the OWM inventory study is included later in this report.

The following are the results of the inventories taken:

Name Brand Inventory

Throughout the year, the IPF has been collecting and inventorying various electronic equipment from the University and local municipalities. Data was collected on the origin of the material and brand name of each piece. Below is a table representing the proportions of each brand name in a variety of categories. The top 3 to 5 are represented for categories with less than 200 items and the top 10 are shown for categories over 200 items. For both UMASS and municipal computer related material, IBM, Apple and Digital consistently have the most items. UMASS did not produce enough consumer electronics to display in a table, but the municipality's brown goods are displayed below.

COMPUTER EQUIPMENT:

UMASS

606 CPU's	58 Drives	399 Keyboards	691 Monitors	212 printers
2.1% Samsung	5.2% Apunix	4.3% Leading Edge	2.2% Digital	3.3% unknown
2.5% Dell	8.6% IBM	6.0% Apple/Mac	2.7% Leading Edge	3.3% Texas Instruments
3.2% Compaq	58.6% Apple/Mac	6.1% Zenith	3.2% NEC	3.8 Wang%
3.9% Leading Edge		7.5% Epson	3.3% Epson	4.7% IBM
4.5% ACI		9.8% unknown	4.3% Samsung	4.7% Okidata
5.3% Epson		19.0% IBM	6.2% Zenith	6.1% NEC
6.6% Zenith		20.8% Digital	6.4% CTX	6.1% Digital
6.7% Apple/Mac			10.6% IBM	6.6% Panasonic
14.2% IBM			11.3% Dell	9.4% Apple/Mac
17.7% Digital			13.2% Apple/Mac	11.3% Hewlett Packard
				17.0% Epson
Total Percentage Represented 66.70%	72.40%	55.50%	63.40%	76%

MUNICIPAL

1367 CPUs	501 Drives	1064 Keyboards	44 Modems	1885 Monitors	673 Printers
1.8% AT & T	1.2% Atari	1.3% Mitsumi	6.8% Apple	1.8% Amdek	2.2% Digital
1.9% Compaq	1.2% Western Digital	1.6% Zenith	9.1% Datatronic	1.8% NEC	2.3% unknown
2.7% Digital	1.6% Laser	1.6% Epson	11.4% Zoom	1.8% Zenith	3.4% Wang
3.3% Epson	5.0% IBM	3.1% Gateway		2.7% Epson	4.2% Hewlett Packard
4.3% unknown	5.8% unknown	4.1% Wang		2.7% Leading Edge	4.5% Okidata
4.4% Leading Edge	69.9% Apple	5.6% Digital		2.8% Wang	4.8% NEC
18.4% Apple/Mac		6.7% unknown		3.2% Samsung	6.4% Panasonic
28.7% IBM		7.0% Leading Edge		5.9% Digital	7.3% IBM
		21.1% IBM		20.6% IBM	14.4% Epson
		22.8% Apple/Mac		23.2% Apple/Mac	24.9% Apple/Mac
Total Percentage Represented 65.60%	84.70%	74.90%	27.30%	66.50%	74.40

BROWN GOODS

MUNICIPAL

40 answering machines	119 phones	160 stereos	55 tape decks	938 tv's	48 typewriters	243 vcr's
10% general electric	4.2% att	3.1% emerson	5.5% panasonic	2.3% quasar	10.4% brmc	2.5% samsung
17.5% panasonic	4.2% bell south	3.1% sound design	7.3% general electric	3.3% sharp	16.6% ibm	2.5% quasar
25% at & t	4.2% southwestern bell	3.8% magnavox	7.3% superscope	3.9% panasonic	20.8% olympia	2.5% toshiba
	4.2% western electric	3.8% panasonic	9.1% realistic	4.8% sears		2.5% zenith
	5.9% unknown	3.8% sears	12.7% sony	5.4% sony		2.5% sharp
	6.7% panasonic	3.8% unknown		5.7% sylvania		2.9% sylvania
	37% at & t	6.3% realistic		5.9% general electric		3.3% jvc
		6.9% sony		6.6% magnavox		3.3% emerson
		11.9% general electric		17.1% zenith		4.5% magnavox
				18% rca		4.9% general electric
						7.4% fisher
						8.2% panasonic
						9.5% unknown
						10.3% rca
Total Percentage Represented 52.50%	66.40%	46.50%	41.90%	73%	48%	66.80

Detailed Inventory

Monitors		
Screen size	Average year of manufacture	Type
25.68% 12"	1989	74.6% non-VGA
23.33% 14"		25.4% VGA
15.88% 13"		
10.55% 9"		
10.30% 10"		
average = 12.1"		

TV's	
Screen size	Average year of manufacture
6.1% 17"	1983
8.1% 12"	
9.6% 13"	

10.1% 27"	
33.9% 19"	
average = 18.6"	

CPU's	
Speed	Average year of manufacture
12.7% 286's	1990
19.6% 486's	
29.3% 386's	
61.6% unknown	

Printers	
Type	Average year of manufacture
92.1% dot matrix	1989

Modems	
	Average year of manufacture
	1988

Keyboards	
	Average year of manufacture
	1984

Brown Goods Study

During the summer of 1999, the OWM performed a study on non-computer consumer electronic equipment (brown goods). There were two main goals in researching the brown goods waste stream. One was to assess the average age of material collected. The other was to analyze costs and presumed value added by demanufacturing these materials.

For the purpose of this study, "brown goods" included such items as TV's, VCR's and stereo equipment. The materials were from residential sources, collected at the IPF at the one-day drop off events or delivered by local municipalities. Each item to be included in the study was weighed and inspected for a date of manufacture and name brand. This information was noted and the dismantling staff would then record the start time and separate each component into the following categories: A Boards, Aluminum, CRT's, D Boards, Iron-Aluminum, Scrap metal, Transformers, Trash, Wire, and

Yolks. When all demanufacturing was complete, the total weight from each of the categories was calculated and recorded.

The data collected by the dismantling staff was transferred from the record sheets into an MS Excel spreadsheet. Calculations were made for demanufacturing time, average year of manufacture, average weight, and cost or revenue for disposal or recycling of each material.

There were mixed results in attaining the goal of an age assessment of the materials collected. Thirty-one televisions were studied ranging from 1973 to 1989 for an average age of manufacture of 1982. These TV's were chosen at random from the supply within the IPF. A total of forty-two VCR's were used, ranging from 1984 to 1989 and averaged to 1986. The stereo equipment did not yield any usable information as to the year of manufacture. There were so few items that had this information that any average calculated would not have been a fair representation of the entire load. It should also be noted that of the 31 TV's and 42 VCR's studied; many did not contain information on date either.

Included after this text is a spreadsheet (Chart 1) documenting the demanufactured parts of the materials used in this study. As seen on Chart 1, when calculating straight material costs, the demanufacturing operation creates revenue. Total revenue equals $142 and costs for recycling CRT's and trash disposal are $119 for net revenue of $23. Had these materials gone to the landfill, our tip fee would have been $104. Therefore, one could say that demanufacturing and recycling this equipment was a $127 benefit to the IPF. The procedure becomes less attractive when labor costs are factored in. The total cost to perform the demanufacturing is $407. As seen on Chart 2, all items studied except for televisions took 3-4 minutes per pound to demanufacture. TV's take only 1 to 1.5 minutes per pound. We found similar time requirements for TV's and computer electronics in the OWM's Scrap Electronics Project Report submitted to the Chelsea Center in June 1998. The longer demanufacturing times for other brown goods may be due in part to the fact that our laborers were unfamiliar with this equipment and know TV's and computers much better. Another factor is that there tends to be a lot more small pieces in the brown goods that do not have a lot of weight. This causes high labor costs for very little return in revenue.

The hopes of determining a reliable date of manufacture for all materials were not well met in this study. The nature of the equipment collection may be part of the problem. Because much of the material came from the one-day collections at the UMASS facility, most of it looked like the kind of things that have been sitting in the basement for years. Many items were missing the parts that may have had the date information or they simply never had such information attached. This was especially true of the stereo equipment. These collections represented first time clean out for many residents and as the electronics-recycling program continues, the equipment should be newer and newer. In the "Detailed Inventory" section of this report, average age of manufacture is represented for TV's collected after the Brown Goods Study was concluded. There was larger data set to choose from so that is a more representative date than the Brown Goods Study TV date.

In terms of cost, most brown goods seem much less worth demanufacturing than computers or televisions. Stereo equipment ends up having a large portion of trash (plastic, wood, etc.) and takes a long time to take apart. VCR's are similar, but repair shops indicate a high success rate for repair and resale so that may be the best avenue for them. TV's are most worth demanufacturing of all items studied. A bald CRT is much less expensive to send to the recycler than a whole television. In addition to a lower per pound charge for bald CRT's, there would be less total weight going to the recycler. There is circuitry, wire, and a yoke that are revenue items in TV's that help offset the cost of

disposal of the casing. The value of demanufacturing TV's would depend heavily on the scale of an operation.

Chart 1

	pounds	Price per pound	Revenue/cost
A Boards	66	1	66
Aluminum	52	0.2	10.4
CRT's	944	-0.1	-94.4
D Boards	273	0.055	15.015
Iron-aluminum	112	0.09	10.08
Scrap Metal	772	0.007	5.404
Transformers	160	0.07	11.2
Trash	912	-0.028	-25.08
Wire	155	0.15	23.25
Yolks	23	0.05	1.15
	3469		23.019

Chart 2

Unit Type	Average weight (lbs.)	Average year of Manufacture	Average Demanufacture time (minutes)
TV	52.9	1982	39.5
VCR	14.8	1986	35.1
Tape Deck	7.25		20.2
Portable radio	8.2		23.9
Turn Tables	15		33.7
Receivers	11.8		37

One Day Collections

Part of the grant agreement required the IPF to host two drop off events open to all residents of Franklin, Hampshire, and Hamden counties on April 17 and May1, 1999. Any resident of these counties could bring their unwanted electronic equipment to the facility between nine and noon. Residents were allowed up to four CRT items and unlimited non-CRT items free, but anyone with more than four CRT's was charged $5 for each CRT over four. This policy was implemented to account for the possibility of businesses trying to take advantage of free CRT disposal. We also anticipated there would be some hobbyists who repair TV's that would not technically be a business but did not fall under the normal residential classification. The charge was directed at each of these groups. Most people had no problem with this policy, but there were some complainers and even a

few people who refused to give their old TV's if they had to pay. (I think some of them drove around the block and came right back).

The collections were successful. There were just under 600 cars for the two days producing approximately 33 tons of material. One third of all participants were from the town of Amherst. Approximately another third of the participants came from towns directly bordering Amherst. The last third came from a variety of locations, some as far as a 45-minute to an hour drive. About 120 gay lords were filled and there were dozens of additional large console TV's that did not fit into the boxes. The collection was run similar to a household hazardous waste day with 6-9 volunteer staff on site, four OWM student employees, and three OWM employees. The volunteers were essential to inventorying and helping unload the cars. One OWM staff member was constantly running the forklift to remove full boxes and bring in empty ones. The steady flow of traffic kept the forklift operator busy for the entire three-hour period. Without a skilled, experienced operator, the entire day could have been much slower and potentially dangerous. Another OWM staff member was primarily in charge of the onslaught of traffic. He was directing cars to one of two unloading areas and overseeing general traffic flow. The third OWM employee was overseeing the entire site, handling "problem loads," helping the volunteers, and filling in any gaps throughout the day. While the volunteers were extremely helpful to the collection, the regular OWM staff and students were essential. Their experience and knowledge of the electronics recycling process was instrumental in handling small questions and problems without causing major back-ups throughout the day.

At the May 1 collection, Advanced Electronics/ElectroniCycle Inc. participated in the event by "cherry picking" potentially reusable or repairable items. They were stationed at the unloading area, taking any items that were attractive to their business. They had three workers and a box truck that proved to be very helpful. At the start of the collection, they were asked to be sure not to slow down the process of efficiently moving people through the line. With this understanding, their culling ended up giving us extra hands in unloading, saved some gaylord boxes, and lightened the workload for the forklift operator. Advanced culled a total of 116 items weighing 3360lbs. representing approximately 10% of the items collected. 18.1% of these items were not repairable and were demanufactured and recycled. The remaining 81.9% were repairable and went for resale. (See ElectroniCycle report attached)

IPF Management

Several factors have made the electronics project a strain on the operation of the Intermediate Processing Facility. The unpredictable nature of incoming loads has been a consistent problem. Especially at the start of the program, but even to this day, truckloads of electronics arrive unannounced. This takes the time of office staff to alert outside staff of the arrival and is an unplanned burden to the outside staff. These customers are asked to wait until someone is available to help them, but our operation is still disrupted. Another problem is the size of loads. When making an appointment, the customer is asked the size of the load. Invariably, the load is significantly larger than reported or they arrive with several trucks when only one or two were expected. There seems to be a variety of reasons for these occurrences. Sometimes the person scheduling assigns the job to a driver and does not convey the information given them by OWM staff. Other times, the size of the load grows from the time of the appointment to the time of delivery as people in the school or office hear a load of electronics are going for recycling. This creates more OWM staffing problems because there are not enough people available to handle the load so one or two people can be occupied for extended

periods unloading a truck. Such staffing difficulties for problem loads can also prevent handling more than one scheduled appointment in a day. In addition, these unexpected large loads can exceed the number of gaylord boxes we have available to house the material. When this happens, material sits on the ground, cluttering the building and causing double handling of the equipment.

Once materials enter the building, there is potential for more problems. While there is a "no scavenging" policy in place, it does still happen. As material is picked through, it often gets mixed in inappropriate boxes causing staff to invest additional labor time to un-mix materials. Keeping the different categories of materials at opposite ends of the building has helped to a certain extent, but there is still mixing or trash placed in the electronics boxes. The sheer number of boxes is overwhelming as well. There have been as many as one to two hundred cubic yard boxes scattered throughout the building and an additional several dozen pallets loaded with large TV's that would not fit in the boxes. This volume of electronics can hamper the IPF's day-to-day operation. The CRT recycler often takes a few weeks to get here, causing further build up of material. We are now arranging for regularly scheduled pick-ups to avoid material build up. A consistent schedule and limiting electronics collection areas in the facility will hopefully make the building more manageable in the future.

Materials scavenged by TV repair experts from UMass Amherst:

ADVANCED ELECTRONICS

Recycled / Reconditioned Products taken from UMass and Somerville Collection Programs 1999

Item	Brand	Model	DOM	Desc/comment/accessories	Price Sold
AC	Amana	13,700 btu- Lechmere	9.00		300.00
AC	Frigidaire	S174001	10,600 btu (Lechmere $599)		250.00
AC	Panasonic	CW606TU1996	5800 BTU w/book/access.		150.00
BW	Bentley		5" ac/dc b&w w/ac adapter		20.00
CAM	Canon	E65A	1991	8MM/10x zoom/w/case/light	
CAM	JVC	GR-EZ1	VHS-C		
CAM	Panasonic	PV-D406	VHS-C/16x zoom/4hd		
CAM	Sony	CCD-FX730	1994	8MM/12x zoom/w/chgr/bat	
CAM	Sony	CCD-TR5	8MM/6x zoom		
CHG	Canon	CA-100	6v		75.95
CHG	Canon	CA-200	8.5v		55.95
CHG	Canon	CA-900A	8.4v		65.95
CHG	Hitachi	CPS801C	6v		55.95
CHG	Hitachi	CPS801C	6v		55.95
CHG	Hitachi	CPS801C	6v		55.95

CHG	Hitachi	CPS801C	6v		55.95		
CHG	Hitachi	CPS801C	6v		55.95		
CHG	JVC	AA-V10U	6v		72.95		
CHG	JVC	AA-V11U	6v		72.95		
CHG	JVC	AA-V35	6v		84.95		
CHG	JVC	AA-V3U	6v		72.95		
CHG	Magnavox	V80147BK01	9.6v		60.95		
CHG	Panasonic	PV-A11	9.6v		55.95		
CHG	Sharp	UADP-0129GEZZ	6v		80.95		
CHG	Sharp	UADP-0156GEZZ	6v		90.95		
CHG	Sony	AC-V30	6v		50.95		
CHG	Sony	AC-V30	6v		50.95		
CHG	Sony	AC-V316	8.4v		75.95		
CHG	Sony	AC-V500	8.4V		92.95		
CHG	Sony	AC-V500	8.4v		92.95		
CHG	Sony	AC-V60	6v		55.95		
CHG	Zenith	VAC620	9.6		50.95		
CTV	GE	19GT352	1995	19"stereo w/new remote	95.00		
CTV	Goldstar	CMT9322	1987	19"mono	50.00		
CTV	Hitachi	CT2085	1989	19"mono	50.00		
CTV	Magnavox	RJ4330	1988	20"mono w/remote	65.00		
CTV	Mitsubishi	CS2015R	1990	20"stereo/AV IO/w/remote	85.00		
CTV	Mitsubishi	CS2656R	1988	26"stereo S/VHS AV/IO	99.00		
CTV	Philco	R5050B	1986	26"mono w/new remote	99.00		
CTV	Quasar	TT6298XW	1984	20"stereo loaded(was $1000 new)			100.00
CTV	RCA	E13334WH	1996	13" white cabinet/excellent		99.00	
CTV	RCA	F19201	1994	19"mono w/new remote		75.00	
CTV	RCA	F20514WN	1989	19"mono		50.00	
CTV	RCA	FPR510WR	1988	19"mono		65.00	
CTV	RCA	X20101GS		1994 20"mono w/new remote			100.00
CTV	Samsung	CT2750	1990	27" stereo/S jacks/AV IO		175.00	
CTV	Samsung	TC9895TB	1992	19"mono		75.00	
CTV	Sanyo	AVM1301	1992	13"mono		65.00	
CTV	Sanyo	AVM1902	1993	19"mono very good CRT		75.00	
CTV	Sharp	19RV69	1989	19" mono		50.00	
CTV	Sony	KV13M10	1994	13"mono AV inputs		90.00	
CTV	Sony	KV20TS20	1989	20"stereo AV/IO w/new remote		100.00	
CTV	Toshiba	CF1922J	1990	19"mono		75.00	
CTV	Toshiba	CF2655J	1989	26"stereo AV/IO		99.00	
CTV	Zenith	SM2067BT	1994	20" stereo AV/IO new remote /EXC		125.00	
MON	Acerview	33D	1992	13"		60.00	
MON	Dell	D1528LS	1995	14" nice		75.00	
MON	Gateway	1572FS	1993	14"		75.00	
MON	Gateway	1572FS	1993	14"		75.00	
MON	Laser	6448	1992	13" vga		20.00	
MON	Mag	DX15FG	1995	14" nice but no swivel base		60.00	
MON	Magitronic	CSV1501PS	1995	13.5 "		60.00	
MON	Pionex	TE1422	1992	13" svga – good spare		40.00	
MON	Pixie	PBC1450	1996	13" Lechmere leftover		99.00	
MON	Princeton	Ultra 15	1995	rare cond/like new		125.00	
MON	Samsung	CVM4967P	1994	13"		60.00	
PRI	Epson	FX286		wide/heavy duty/w/new ribbon		100.00	
PRI	NEC	P5200		w/new ribbon		100.00	
PRI	Panasonic	KX-P1124		w/book/new ribbon		100.00	
PRI	Panasonic	KX-P2123		w/box/book/new ribbon		100.00	
STE	Phase Linear	1000		noise red. – sold w/ SA-9100		-----	
STE	Pioneer	CT-F9191		Cassette – sold w/SA-9100		-----	
STE	Pioneer	RG-1		processor – sold w/SA-9100		-----	
STE	Pioneer	SA-9100		amp – mint condition w/box		400.00	
TEQ	Archer			antenna rotor & control-looks new		40.00	
TEQ	Philips	PM3215		50mhz dual trace/w 1 new probe		500.00	
TEQ	Tektronix 200-1			scopecart (new $465.00)		150.00	
TOL	B&D	7144		3/8"VSR drill/factory refurb		25.00	
TOL	B&D	7190		3/8"VSR drill heavy duty		25.00	
TOL	B&D	7447		3X21 belt sander/factory refurb		30.00	

H: Attachments

TOL	B&D	7548			VS jig saw/factory refurb		25.00	
TOL	Dewalt	DW106	3/8" VSR drill (120v)				50.00	
TOL	Makita	5007NB	7 ¼" circular saw				60.00	
VCP	Audiovox	AVP4000	1988	2hd	AC/DC		65.00	
VCP	JC Penney	6221	1994	2hd	AC/DC		75.00	
VCR	Akai	VS303	1985?	2hd			40.00	
VCR	Fisher	FVH7300 1990	4hd excellent				75.00	
VCR	Fisher	FVH830 1985	4hd				30.00	
VCR	Fisher	FVH920 1986	2hd dolby stereo				50.00	
VCR	GE	1VCR5004	1984	2hd			30.00	
VCR	GE	9-7215	1986	2hd			30.00	
VCR	Goldstar	GHV1265M	1986	2hd			30.00	
VCR	Hitachi	M270	199?	4hd			75.00	
VCR	JVC	HR-D180U	1985	4hd			30.00	
VCR	Magnavox	VC9040	199?	4hd			75.00	
VCR	Magnavox	VR9510	1986	2hd			30.00	
VCR	Magnavox	VR9550	1986	2hd			30.00	
VCR	Panasonic	PV1322	1984?	2hd			30.00	
VCR	Panasonic	PV1535	1985	4hd			40.00	
VCR	Panasonic	PV1535	1985	4hd			40.00	
VCR	Philco/Mag	VR8405	1985	2hd top load			30.00	
VCR	Quasar	VHQ560	1995	4hd/hi fi/ exc.			90.00	
VCR	RCA	VMT385	1986?	2hd	w/remote		30.00	
VCR	Realistic	16-509	1984?	2hd			30.00	
VCR	Sears	?	1988	2hd			30.00	
VCR	Sears	934.53370650		2hd dolby stereo			30.00	
VCR	Sears	934.53450650	1985?	2hd			30.00	
VCR	Sharp	VC682U	1986	2hd			30.00	
VCR	Sharp	VC683	1985	2hd			30.00	
VCR	Sharp	VC6847	1986	2hd			30.00	
VCR	Sharp	VC797U	1986	4hd	excellent condition		60.00	
VCR	Sony	SLV575	mint				200.00	
VCR	Sony	SLV585	perfect				200.00	
VCR	Sylvania	VC8940	1986	2hd			30.00	
VCR	Symphonic	SV211E	1993?	2hd	w/remote			50.00
VCR	Tatung	VRH8300U	1984?	?	w/remote		30.00	
VCR	Toshiba	M222	199?	2hd	181ch		75.00	
VCR	Toshiba	M6000	1985?	2hd			30.00	
VCR	Toshiba	M7855	198?	4hd			60.00	

Advanced Electronics / Electronicycle Inc. Spencer, MA

H: Attachments
Attachment 8

By Professor Bernard Morzuch, University of Massachusetts Resource Economics Department

Job Benefits Of Different Markets: A Value-Added Approach

Suppose that the state must make a decision to deal with used electronic equipment through traditional disposal methods, e.g., landfills and incineration, or through market-oriented alternatives, e.g., recycling, repair, or export markets. How should each of these different possibilities be evaluated in order to determine which make(s) the most economic sense?

One way that economists evaluate projects is by calculating the value that a product adds to an economy's output as that product proceeds through its various stages of development, i.e., from its raw-material stage to its finished-product stage. The difference between the price of the finished product and the cost of the raw materials and processes used to get the product to its finished stage is a measure of the value added by inputs and processes at the different stages of production.

A discarded CRT can be looked upon as a product in its raw-material stage. The state faces the decision of dealing with tons of these items. In their final stage, something definitely becomes of them. In this research, we are proposing four options. Option one, if it were legal, is to dispose of them in a landfill or incinerate them. Effectively, we are using the results of this option as the basis for comparing the results of the other options. Options two through four, as indicated above, are to recycle them for reuse, repair them if they are in need of repair and then find a market for them, and export them directly.

To bring these CRTs to their final stage requires resources. It costs to dispose of them, to recycle them, to repair them, or to export them. This resource requirement or cost for each option can be regarded as the value added due to that particular option.

- How is value added to be measured? One way is to calculate the quantity of items that goes to a particular option, e.g., repair. Next, the cost to bring each item to the final stage of that option must be specified, e.g., repair cost per item. Finally, multiply quantity times cost per unit to get value added. Unfortunately, this procedure is difficult to apply. Each option is comprised of many different items. Access to a cost per unit for each different item is effectively impossible because so many heterogeneous units comprise each option.

- An alternative approach to calculating value added is to use the amount of labor required to bring the product from its raw-material stage to its final-product stage. This particular procedure becomes particularly convenient for the quantity of electronics (in tons) headed for each option. If an accurate estimate can be made of the numbers of jobs (or people employed) needed to bring a given tonnage of electronics to its final stage, e.g., repair, then this employment represents value accruing to the economy that would otherwise be absent if this activity, e.g., repair, did not take place. Notice that similar calculations can be performed for the three remaining options. The options can then be ranked according to the employment provided.

Sources Of Information

We begin with the premise that a spent piece of electronics can be discarded or it can be directed to one of three market outlets. Again, these three market outlets are recycling, repair, and export. To determine if these are indeed feasible outlets for used electronics, we administered a survey to possible participants, companies, and organizations within each option. We asked them detailed questions on quantities and employment in that particular option. The survey was administered in person or over the phone. Details on the recycling, repair, and export surveys follow.

Recycling Survey

In 1998 a survey was developed and administered to 48 vendors of used electronic equipment to investigate recycling as an option for this material. Thirty-six vendors provided very complete information on the types of material that they handled. This material included computers, CRTs, scrap metal, circuit boards, and appliances. The vendors likewise provided information on the disposition path of this material. They indicated whether they were involved in recycling, reselling, extracting precious metals from, or donating this material. With the exception of circuit boards, for which the sole disposition was extracting precious metal, the predominant activity was recycling.

The 36 vendors who responded were mostly from Massachusetts, New Hampshire, Rhode Island, Connecticut, and Vermont. One was from Pennsylvania and one from California. Nearly all respondents provided complete information on tonnage handled per month and number of individuals employed. These are the necessary ingredients for calculating value added.

One noteworthy feature about the survey was the manner in which it was conducted. It was administered by an individual who is extremely knowledgeable about this industry. He is in the business of coordinating efforts among transportation companies, reclamation companies, and brokers to create a process for moving recyclables like CRTs at the lowest possible cost. Consequently, in addition to providing information about employment and tonnage, he had the professional background to make poignant observations about the surveyed companies' strengths, weaknesses, and performance in electronics recycling. These observations are the basis for making statements about the existing infrastructure in electronics recycling.

Table 1 provides a summary of five companies that specialize in electronics recycling. These five companies were selected for presentation because of their ability to accept material, process it, and move it out. The identity of the companies is not revealed. They are identified in Column 1 of the table with the consecutive integers 1 through 5. Column 2 of the table shows that two of the companies are from Massachusetts, with one each from Connecticut, New Hampshire, and Pennsylvania. Column 4 provides monthly tonnage handled by these companies, Column 5 the number of employees, and Column 6 yearly tonnage per employee. Figures in this column are calculated by taking monthly tonnage in Column 4, multiplying by 12, and dividing by the number of employees in Column 5.

Tons of CRTs handled per employee range from a low of 240 to a high of 4000. If we were interested in a summary measure that captures a representative tonnage handled per employee, we would want to avoid the extreme influence displayed by the first company. Thus, we would use the median of these five observations. The median is the observation appearing in the middle, after

arranging all of the observations from low to high. For these data, the median is 533 tons per employee. It is this figure that will be used when making comparisons with the other alternatives.

Column 7 provides information about the degree to which these companies are developed in the electronics recycling industry. This column suggests that outlets other than landfills and incinerators definitely exist and are quite capable of dealing with spent CRTs and electronics equipment. The task remains to develop this existing infrastructure further.

Repair Survey

An additional source of spent CRTs is television sets. In 1999, another market survey was developed to evaluate whether changes in the television industry might affect the volume of electronics equipment being disposed of in Massachusetts. More specifically, each television repair company in the state was contacted to determine whether it would be willing to refurbish and resell televisions through the state's electronics recycling program.

Information was obtained from 176 respondents. Of these, 58 indicated an interest in participating in the program, 20 said maybe, 78 said no, and 18 did not respond to this question. If "maybe" is interpreted as a positive response, half of those who responded to the question would have an interest in participating in the program.

Particularly important information obtained from the survey was each company's volume of televisions repaired per month and its number of employees. Those responding reported a total of 12,457 monthly television repairs. The total number of employees performing this task was 466. To get a measure of overall yearly employment activity in this sector of the Massachusetts economy, we began by taking the total number of monthly television repairs (12,457) and multiplying this figure by 12 to provide an estimate of yearly television repairs (149,484). Next, the total number repaired was converted to tonnage repaired. One source suggested that approximately 40 televisions equated to one ton; another source used 50 televisions to equal one ton. For our purposes, we used 45, the average of 40 and 50, to equate to one ton.

The total number repaired was converted to tons repaired by dividing 149,484 by 45. The result is 3,322 tons of televisions repaired annually. Next, we took tons repaired annually (3,322) and divided this figure by the number of employees doing repairs (466) to get seven tons of televisions repaired per employee. It is this figure that will be used when making comparisons with the other alternatives.

Export Survey

In 1999, a telephone survey was administered to companies that export used electronic equipment. The purpose was to determine the degree of interest among exporters for used televisions, computers, parts form this equipment, CRT glass, and plastic housings. Of the three types of surveys administered, the export survey provided the least usable information. Perhaps because export companies are so heterogeneous regarding the types of goods with which they deal, only one company was willing to match the number of employees uniquely associated with used electronics. This company, located in New England, told us that it handled 2,250 tons of used electronics annually. Eight employees were responsible for preparing this material for export. Using just this one survey result, one employee handles on average 281 tons of used electronics (2,250/8) to be exported each year.

Ordinary Methods Of Disposal

To put the results of Sections 5.2-5.4 into perspective, we begin by doing similar calculations when the outlet for used electronics is disposal either in a landfill or by way of incineration. These calculations will serve as a benchmark for determining whether or not the three market-oriented alternatives lead to more attractive employment opportunities and, consequently, higher value-added to the state's economy than by disposal.

We came up with an average tonnage disposed per employee at landfills using DEP data. We derived the estimate by summing total yearly tonnage for the top 17 commercial landfill facilities in the state and dividing this result by the total number of employees at these 17 facilities. Our estimate was approximately 23,000 tons disposed each year per employee. An alternative interpretation of this number is that 23,000 tons of material will keep one person employed for a year in the landfill disposal sector.

We estimated average tonnage disposed per employee at incineration facilities by summing total yearly tonnage for the eight active combustion facilities in the state and dividing this result by the total number of employees at these eight facilities. Our estimate was approximately 14,000 tons disposed through incineration each year per employee. Alternatively, 14,000 tons of material per year will keep one person employed in the incineration disposal sector.

Implementing The Survey Results

Each option – recycling, repair, export, and disposal either in landfills or by incineration – provides information on the number of tons of electronics it takes to employ one person per year. The results of Section 5.5 show that 23,000 tons of land filled electronics will employ one landfill worker per year, and 14,000 tons of incinerated electronics will employ one worker at an incineration plant per year. Section 5.2 concludes that 533 tons of recycled electronics tends to employ one worker per year at a company that specializes in electronics recycling. Section 5.3 concludes that seven tons of televisions in need of repair will employ one worker per year at a television repair outlet. Finally, Section 5.4 concludes that 281 tons of used electronics will employ one worker per year in the export industry. This information is summarized in Columns 1, 2, and 3 of Table 2.

How is this information to be used? Suppose that the recycling, repair, and export markets are well developed in accepting, processing, and moving out used electronics equipment. Again, the survey results presented Sections 5.2-5.4 indicate that these markets may be moving in this direction. Also suppose, by way of example, that one ton of unwanted television sets becomes available as a result of a special municipal collection program. Even if disposal in a landfill were legal, to what outlet should this one-ton be dispatched? Should it be landfill or repair?

From an economic perspective, this question can be answered by noting where the employment effects are greater. Because of the seven-tons to one-job ratio in the television repair sector, a one-ton increase would require an additional $1/7^{th}$ (or 0.1428 as a proportion) of a worker's services per year if the tonnage were headed for the repair sector. Because of the 23,000-tons to one-job ratio in the landfill sector, a one-ton increase would require an additional $1/23{,}000^{th}$ (or 0.0004 as a proportion) of a worker's services per year if the tonnage were headed for the landfill sector.

To give these proportions additional meaning in the context of value-added, suppose that a worker in any of the outlets for used electronics earns $35,000 per year. If an additional ton of

electronics is directed to the repair market, requiring 0.y1428 of a repair worker's services per year, this translates into an additional $4998.00 (= 0.1428 x $35,000) accruing to a repairperson per year. Alternatively, this is the value-added by the repair sector, which results from making defunct electronics usable.

If, on the other hand, the additional ton were permitted to be directed to a landfill, requiring 0.00004 of a landfill worker's services per year, this translates into an additional $1.45 (=0.00004 x $35,000) accruing to a landfill worker per year. Comparing these two calculations, we see that value-added to the state's economy, solely from the perspective of employment effects, is higher if the material moves to the repair sector. Obviously, at some point the repair market becomes saturated with used televisions. At this point the other markets would take over, e.g., recycling television CRTs and dismantling the remainder for scrap.

Similar comparisons can be made between landfill (or incineration) and the two remaining market outlets, i.e., repair and export. Summarized calculations to do the comparisons are presented in Columns 4 and 5 of Table 2. For example, suppose that a special collection results in one ton of CRTs being collected and that the choice is between incineration and recycling these units. The additional worker time required if the outlet is recycling is 1/533rd (or 0.0018 as a proportion) of a worker's services per year. Value-added by the recycling sector would be $63.00 (= 0.0018 x $35,000) per year as a result of its recycling activities. If the additional ton were permitted to be incinerated, 1/14,000th (or 0.00007 as a proportion) of an incineration worker's services per year would be required. Handling the material with this option would result in value-added in the amount of $2.45 (= 0.00007 x $35,000) per year. Comparing these two options, we see that employment and value added effects are greater if this volume is dispatched to recycling rather than to incineration.

H: Attachments

Table 1: Five Companies That Specialize In Electronics Recycling

Company	State	Specialty	Capacity	Employees	Tons per year per employee	Comments
1	CT	Full-service recycler	15,000 tons/mo	45	4000	Able to demanufacture and sort incoming electronics
2	MA	Full-service electronics recycling and resale	300 tons/mo	15	240	Investing in grinders and smelting equipment in order to provide full-service recycling of electronics
3	NH	Electronics recycler	866 tons/mo	26	400	One of the most complete recycling processes in New England handling all aspects of CRT and CPU recycling
4	MA	Electronics demanu-facturing	400 tons/mo	9	533	A full service recycler processing CPUs and CRTs.
5	PA	CRTs	6000 tons/mo	130	553	One of the most complete CRT recycling programs in the Northeast.

Table 2: Material Handled and Value-Added Calculations Per Worker Per Year In Each Outlet

Market For Used *Electronics*	Tons Handled Per Employee *Per Year*	Source In ***Text***	Proportion Of Worker Time Needed To Handle One Additional Ton In This Category	Value Added To State Economy Per Year If A Worker Earns $35,000 Per year
Landfill	23,000	Section 5.5	1/23,000 = 0.00004	$1.45
Incineration	14,000	Section 5.5	1/14,000 = 0.00007	$2.45
Recycling	533	Section 5.2	1/533 = 0.0018	$63.00
Repair	7	Section 5.3	1/7 = 0.1428	$4998.00
Export	281	Section 5.4	1/281 = 0.0035	$122.50