EXPANDING WORCESTER POLYTECHNIC INSTITUTE'S RECYCLING PROGRAM TO INCLUDE BOTTLE AND CAN COLLECTION

A FEASIBILITY STUDY

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Abstract

As of January 2008, Worcester Polytechnic Institute only recycles office mix, cardboard, batteries, and computer electronics. A major component missing from WPI's current recycling program is plastic, glass, and aluminum bottle and can collection. This report summarizes the history of waste management and the benefits of recycling, reviews WPI's existing recycling practices, and presents options for implementing can and bottle collection. Based on our research, the best plan of implementation is proposed and suggested for adoption by the WPI community.

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1 Introduction

Mother Nature. Lady Earth. Our Environment. Regardless of where you are, whether you're sitting at work in a cubicle going through the daily grind or immersed in the vast expanse of the Sahara Desert, you're always surrounded by the environment, interacting with it and slowly changing it. You may not even realize how your actions are affecting it.

Consider a farmer who provides a community with locally grown, fresh, organic produce, but whose tractor emits harmful air pollutants into the very same community by burning fossil fuel. Or perhaps consider the paper these words were printed on, not to mention the countless drafts, edits, additions, and notes that arose in the creation of this final document. While paper has provided an effective form of media to communicate our goals of resource conservation and recycling, we may very well have inadvertently contradicted ourselves considering that many large paper companies are wiping out natural rainforest land in order to acquire raw product materials. Each action we make, as individuals and as a collective society, can result in drastic effects on our surroundings. Even the compilation of seemingly inconsequential acts, such as preparing this report, can contribute to an environmental catastrophe.

Take, for example, global warming which in recent years has become a widespread concern threatening to drastically change our world as we know it. No single entity can be singled out as causing the oncoming climate change. In fact, a portion of these changes can be attributed to natural occurrences in the Earth's cycle (Basic Information, 2007). However, a majority of our industrial and agricultural activities are considered major greenhouse gas producers that have been contributing to the rapid increase in the

Earth's temperature over the last fifteen years (Basic Information, 2007). Although the long term effects of global climate change are difficult to predict (Basic Information, 2007), a variety of potential threats have been posed including decreased air and water quality (Health, 2006), higher temperatures, drought, wildfires, severe rainstorms and hurricanes, a rise in sea levels, and ecosystem and species extinction (Consequences of Global Warming, 2006). All thanks to our contribution of greenhouse gases since the start of the Industrial Revolution (Basic Information, 2007). Think for a moment about how these threats may be avoided if we recognized how our actions affect the climate, changed our practices, and reduced or eliminated manmade greenhouse gas production.

A call for social responsibility must be made. Aside from global warming there are an abundance of environmental concerns requiring our attention, each with their own unique effects on human health, climate, and ecosystems. An endless amount of information is available debating the validity of these and many other concerns, but if serious thought and consideration is not taken we risk drastically hurting our future. Until we begin acting with restrain and awareness of how our actions may affect our global and immediate environment, we are on a steady path having dire environmental consequences.

An important issue among the various environmental threats existing today is the depletion of our natural resources and the need for successful recycling programs that prevent mass consumption of these limited resources. Continued consumption of our natural, non-renewable resources results in the release of environmental pollutants, aids global warming, causes mass production of waste because of a perpetuated ‘buy and replace’ mentality, and consequently leads to the eventual depletion of our resources. If

this continues, our valued natural materials will end up buried in a landfill, unable to be used.

There exist a variety of programs worldwide that aim to reduce the amount of resources being harvested; However, these programs vary in effectiveness and are limited to corporate cooperation, public awareness, and participation. The scale of these projects range from community based to nationally implemented. Currently are no government mandates regarding the recycling of common household goods such as paper, plastic, glass, and aluminum in the United States. Due to this, the responsibility to recycle has fallen upon cities, towns, private organizations, and communities that have chosen to take an initiative and enforce their own recycling regulations.

As a private institution priding itself on science and technology, the campus of Worcester Polytechnic Institute (WPI) has both the justification and the capacity to run an effective recycling program. Unfortunately, there is currently no consistent campus-wide system in place that responsibly manages all of the University's recyclable wastes. Due to WPI's growing involvement in sustainable design and green engineering and as a leading science and technology University, it is in the school's best interest to be an environmental leader and run a comprehensive recycling program like many schools have already done. This report investigates various aspects of recycling and provides mechanisms in which Worcester Polytechnic Institute can become a valued participant in recycling.

1.1 Project Description

Recycling on Worcester Polytechnic Institute's campus is becoming a prominent issue, with some members of the student body, faculty, and staff expressing a desire to be environmentally conscious with their wastes but having no consistently available, campus-wide outlets to dispose of it. At this point in time, WPI only recycles office mix paper, cardboard, batteries, and computer electronics. A major component missing from the University's current recycling program is the collection of plastic, glass, and aluminum goods typically in the form of cans and bottles. This report aims to provide a solution to this problem, covering a breadth of topics. The report presents the history of waste management practices on a global, national, and local level, gives an overview of commonly recycled products, reviews the current practices at WPI, and provides a variety of options for implementing a recycling program on campus. Based on our research, the best plan of implementation has been proposed and is suggested for adoption by the WPI community.

2 Background

Before addressing the potential recycling options on the WPI campus, it is important to learn a bit of background on recycling so that you have a deeper understanding of what recycling involves and why it is important.

2.1 Commonly Recycled Goods

Whether or not an industry will use a recyclable material largely depends on the following factors: demand, economic benefits, incentives, uses for the material, regulatory requirements regarding quality, and the need to update equipment or install new technology (Pichtel, 2005). The following gives an overview of four commonly recycled goods: paper, plastic, aluminum, and glass.

2.1.1 Paper

Paper makes up approximately 38 percent of the municipal solid waste (MSW) stream in the United States; more than any other material found in the waste stream (Pichtel, 2005). As a result of its dominance it takes up a large amount of space in collection trucks and landfills. Our continued disposal of paper products as trash has lead companies to continuously harvest trees in order to produce new paper products.

Virgin paper is manufactured out of both hardwood and softwood trees (Pichtel, 2005). A mixture of both fibers is used for optimal strength and appearance (Pichtel, 2005). Manufacturing paper out of virgin fibers requires several steps. First wood chips must be turned into pulp, separating the cellulose fibers from lignin, a glue-like agent that holds the fibers together (Powelson, 1992). This is done through one of three processes: mechanical pulping, chemical pulping, or a combination of the two (Pichtel, 2005). Mechanical pulping greatly reduces the length and strength of the fibers through its

grinding process, typically leaving most of the cellulose and lignin still combined (Powelson, 1992). This leads to a lower quality paper that is frequently used for newspapers and magazines (Powelson, 1992). Chemical pulping can be achieved through a variety of processes including kraft pulping, sulfate pulping, and alkaline pulping (Powelson, 1992). This leads to a higher quality paper that is often bleached afterward to whiten the paper and further increase the paper's quality (Powelson, 1992). After the pulping process, the pulp goes through several steps including forming, drying, pressing, and finishing to create a final paper product (Pichtel, 2005).

The virgin paper production process previously described releases a variety of chemicals into the environment. For example, pulp bleaching is often performed in a 5 stage process in which elemental chlorine and chlorine dioxide are used (Greer, 1996). This results in organochlorine contamination (Greer, 1996). Most notably, the production and use of chlorine bleach creates dioxins which are toxic, persistent, and likely to bioaccumulate leading to cancer, birth defects, and damage to the reproductive, neurological, and digestive systems, even at low doses (Greer, 1996). The act of harvesting trees also has negative effects. For example, when Aracruz Celulose SA harvests their eucalyptus plantation, they destroy tropical soils, the water table, and biodiversity in the process (Greer, 1996). Considering the chemical releases and physical damage that results from virgin paper production, recycling paper is a cleaner, safer, and less destructive alternative.

Upon physical inspection it is nearly impossible to tell the difference between paper made from virgin fibers and paper made from recycled fibers (Powelson, 1992). Similar to virgin fibers, recycled paper goes through a mechanical pulping process. A

continuous pulper grinds the paper into a smooth pulp while removing any additional materials such as glues, plastics, and metals (Pichtel, 2005). Chemical treatments and screening then remove ink from the pulp, and sometimes the pulp is bleached to produce a whiter paper (Pichtel, 2005). From this point on, the pulp follows the same manufacturing steps as virgin fibers (Pichtel, 2005), being formed into sheets, pressed, and finished to create a final paper product. During the processing of recycled paper, the fibers incur a decrease in strength, flexibility, and brightness, typically requiring the addition of virgin pulp to maintain the paper's integrity during final use (Pichtel, 2005). A variety of recycled paper grades are available, with high grade recyclables such as manila folders and computer paper used as direct pulp substitutes, and bulk grade recyclables such as newspaper and corrugated cardboard used to make items such as paperboard and construction paper (Pichtel, 2005).

In 1999, paper and paperboard recycling reached 45 percent recovery in the United States (Pichtel, 2005). According to statistics from the American Forest and Paper Association, 70.1 percent of corrugated cardboard, 68.9 percent of newspapers, 43.2 percent of office paper, and 37.8 percent of printing and writing paper are recycled in the United States. However, only 25.5 percent out of the 72 million tons of paper products used in the United States is made out of recycled paper (Pichtel, 2005). This pales in comparison with Japan and the Netherlands who use nearly 50 and 70 percent recycled paper goods respectively (Pichtel, 2005). Using recycled papers can save a considerable amount of energy and trees and prevent the release of toxic wastes. Each ton of paper recycled saves up to 17 trees, 4,100 kilowatts of energy, 7,000 gallons of water, and 3 cubic yards of landfill space (Pichtel, 2005). Additionally, fewer chemicals are needed

during recycled paper processing, resulting in 74 percent less air pollution and 35 percent less water pollution (Greer, 1996). There are many positive benefits to recycling paper. While 45 percent of our paper is disposed of for the purpose of recycling, industries have not been giving us a return for our deposits considering only 25.5 percent of our paper products are made out of recycled materials. To maximize the full benefits of paper recycling, we must strive to increase our recycling rate as well as pressure industries to use our recycled materials.

2.1.2 Plastic

Plastics are an indispensable part of our lives, providing "shatter-resistant, waterproof, lightweight, durable, and strong" (Pichtel, 2005) materials for consumer goods. Today, plastics make up 30 percent of landfill space. That's up to 10 times more compared to 1970 when plastics made up just 2 to 3 percent of municipal solid waste (Pichtel, 2005).

Plastics are commonly made out of "natural gas, petroleum, and liquefied petroleum gases" (Pitchel, 2005) and are typically formed through one of three processes: extrusion, blow molding, and injection molding. Long polymer chains of hydrocarbon monomers make up the structure of plastics. Plastics with linked chains are called thermosets and plastics with nonlinked chains are called thermoplastics. Thermosets make up 90 percent of all plastics produced, and once formed cannot be remolded because of their interlinking bonds which create a rigid structure. On the other hand, thermoplastics can be melted and reformed making them good candidates for recycling. (Pitchel, 2005)

Recycling plastic is a complicated process because of the more than 150 types of plastic resins available (Powelson, 1992), their properties, and the different processing

they have undergone (Pichtel, 2005). This can make sorting difficult, requiring a lot of manpower and generating expenses (Powelson, 1992). New sorting technologies are being developed which separate the various resins by "infrared sorting, laser reading of an encoded label, chemical marking of different resins, and density separations" (Powelson, 1992). Sorting is essential because contamination of one type of resin with another during the recycling process can completely destroy the integrity of a plastic (Powelson, 1992). Other contaminants that must be removed from plastics before recycling include metal lids and caps, dirt, and stones since these do not melt at the same temperature as plastic and can get stuck in machinery (Powelson, 1992).

Seven major types of plastics are voluntarily labeled for ease of recycling. These labels, shown in Figure 2.1, include PET, HDPE, PVC, LDPE, PP, PS, and Other. HDPE and PET are the most commonly recycled plastics and have a large market in both the United States and Asia. (Pichtel, 2005)

(Pichtel 152)

Figure 2.1 Voluntary Plastic Labeling Icons

HDPE is chipped into small flakes about 1 centimeter across. These flakes are then washed with hot water and detergent to remove labels, adhesives, and dirt and are then dried. The flakes can be sold as is, or can be melted, colored, and formed into pellets for use in injection molding. When the flakes are melted down, they pass through a screen which removes solid impurities that may be present. PET recycling goes through similar steps to that of HDPE with the addition of electrostatic precipitation which

removes the aluminum often used with PET containers. There exists a large market for recycled PET, including textiles, fiber filling for pillows and jackets, and reuse in the bottling industry. (Pichtel, 2005)

While a variety of collection programs exist nation wide, the actual amount of plastic that is recycled is very small. Only 5.6 percent of plastics are recycled in the United States (Pichtel, 2005). Plastics recycling prevents over-consumption of petroleum, saves landfill space, and reduces the level of dioxins produced from trash incineration (Powelson, 1992). Unforunately, many plastic items such as "children's toys, computer housing, car fenders, lawn furniture, and automotive plastics" (Powelson, 1992) are not recycled because there is no return program easily accessible for the owners (Powelson, 1992).

Currently, there are a few cost hurdles to overcome in the plastic recycling industry. Transportation can be an issue because plastic is light weight and rigid, taking up a large amount of space while drastically falling short of weight requirements for trucks and railcars. Production costs are also high for some recycled plastics, and industry is skeptical of the quality of recycled plastics even though plastics can be recycled to near-virgin quality. Manufacturers frequently ask for discounted prices on recycled plastics because of their skepticism despite comparative quality and high virgin production costs. PET and HDPE are the most commonly recycled items and most economically attractive plastics. Currently, recycling other types of plastics costs more than the plastic's market value; However, if large quantities of other resins can be collected the price to recycle it would drop below virgin costs and become more economically feasible. (Powelson, 1992)

2.1.3 Aluminum

Virgin aluminum production begins with mining bauxite ore, a mineral. Industry typically uses the Bayer process on the ore, putting it through extraction, decomposition, and calcination to create alumina which is then smelted and often mixed with alloys to suit its intended use. (Pichtel, 2005)

The amount of aluminum scrap and aluminum cans that are recycled is relatively high thanks to community collection programs and container deposit legislation. The Institute of Scrap Recycling Industries specifies a set of standards for aluminum can recycling, and in general, the U.S. has strict requirements for accepting aluminum cans. Aluminum must be clean of dirt, oil, and grease and cannot be mixed with lead, copper, brass and other nonferrous materials. They also must be dry, containing no more than 4 percent moisture. Fees are charged for any materials supplied with over 2 percent moisture. Once meeting these standards, the cans are shredded and sent to a delacquering oven where any coatings or moisture are removed from the aluminum. Next, the aluminum passes through a screen to remove any dirt. It is then melted in a 1400 degree Fahrenheit furnace, and alloys are added as desired. The molten aluminum is then cast into rectangular ingots that are then flattened to about 1.25 centimeters, softened by annealing, and rolled up. (Pichtel, 2005)

The amount of aluminum being recycled in the U.S. peaked in 1992 at 65 percent of generated aluminum, however has been on the decline since then (Pichtel, 2005). Nearly 80 percent of all aluminum in the MSW stream is from beverage cans (Pichtel, 2005). A report from the Container Recycling Institute indicated that in 2001 more cans were thrown away than recycled, resulting in an equivalent waste of energy that could have powered 2.7 million American homes for one year (Pichtel, 2005). Recycling

aluminum has been economically successful for many aluminum manufacturers, and the industry has developed an infrastructure for collection, transportation, and processing (Pichtel, 2005). Recycling aluminum is beneficial because it provides a domestic material source versus the 4 pounds of bauxite ore needed to produce one pound of aluminum, uses only 5 percent of the electric power used to extract aluminum from bauxite, and impurities can easily be removed (Pichtel, 2005). Environmentally speaking, recycling aluminum instead of using virgin materials reduces air pollution by 95 percent and water pollution by 97 percent (Powelson, 1992). Recycling aluminum creates huge environmental and economic benefits for the United States and deserves to be invested in.

2.1.4 Glass

Glass is made out of silica, soda ash, and limestone. These items are heated between 1480 to 1570 degrees Celsius and liquefied. The liquid is then pressed into molds to form items such as bottles and jars, then the items are cooled and annealed to provide strength. (Pichtel, 2005)

Glass makes up approximately 8 percent of the United State's municipal solid waste stream, and is second in success compared to aluminum recycling. According to a 1999 statistic, 23.4 percent of all glass in the nation's municipal solid waste stream was recovered and recycled, and 26.6 percent of all glass containers were recycled. However, the United States still has a way to go, with Japan recycling approximately 50 percent of its glass. Recycled glass is an ideal recyclable for industry, as it undergoes no chemical or physical changes during recycling and therefore maintains the same quality. Glass recycling begins by separation of glass by color, either clear, green, or brown, which is then crushed into small pieces known as cullet. Only glass containers should be recycled together. The addition of non-container items to cullet such as mirrors and light bulbs

warrants the cullet contaminated and unusable because of the materials' differing melting points and properties. Additionally, the cullet must be free of stones, ceramics, dirts, food, and metal, which can be removed during processing. Manufacturers then combine between 10 percent and 80 percent of the recycled cullet with silica, soda ash, and lime, creating new glass. Recycled glass can be used for more than just new containers. Cullet has also been used for fiberglass, glassphalt, and sandblasting materials. (Pichtel, 2005)

Recycled glass has a fairly consistent market, with clear colored cullet drawing in the most money (Pichtel, 2005). Cullet values can range anywhere from $0 to $65 per metric ton for the clearest, non-contaminated cullet (Pichtel, 2005). Recycled cullet has a lower melting point compared to the soda ash, limestone, and silica used when making virgin glass, and therefore saves approximately 2.5 percent in energy costs for every 10 percent of cullet used instead of virgin materials (Pichtel, 2005). Additionally, fewer gaseous emissions are produced when cullet is substituted for virgin materials (Pichtel, 2005). Air pollution is reduced by 20 percent, mining waste is reduced by 80 percent, and water use is reduced by 50 percent (Powelson, 1992). Using recycled glass also benefits the manufacturer by causing less wear on furnaces and reduces transportation costs because cullet is typically purchased in a location closer to the facility compared to virgin resources (Pichtel, 2005). For approximately every ton of cullet used, 9 gallons of fuel oil is saved from the glass manufacturing process (Powelson, 1992).

Bottles deposit laws have been a successful way in accruing materials for cullet. There has also been market legislation passed which requires manufacturers to use cullet. California law required manufactures to use at least 15 percent cullet in bottles in 1992 and 65 percent by 2005. (Powelson, 1992)

2.1.5 Summary and Impact

There are a significant number of benefits to recycling paper, plastic, aluminum, and glass including saving energy, reducing air and water pollution, conserving our natural resources, and reducing costs. Table 2.1 summarizes these benefits. It is important to understand that recycling will have the greatest impact on our Earth if performed on a wide-scale level with each individual, organization, community, town, state, and country participating. In order to gain the most from the benefits of recycling, organizations such as WPI must set an example and take the first steps in voluntarily recycling and developing successful programs that perpetuate these benefits. With such a large and influential institution setting an example, more and more groups will begin to recycle and eventually recycling and its benefits will become a global standard.

Table 2.1 Benefits of Recycling

Material	Benefits of Recycling Compared to Virgin Production
Paper	• Fewer chemicals used • 74% less air pollution • 35% less water pollution • Each ton recycled saves: o 17 trees o 4,100 kilowatts of energy o 7,000 gallons water o 3 cubic yards landfill space
Plastic	• Near virgin quality • Large market for PET • Prevents overconsumption of petroleum • Saves landfill space • Reduces dioxins produced from trash incineration
Aluminum	• Economically beneficial • Uses 5% of electricity needed for aluminum extraction from bauxite • Reduces air pollution by 95% • Reduces water pollution by 97%
Glass	• Incurs no chemical or physical changes during recycling • Every 10% used saves 2.5% in energy costs • Fewer gaseous emissions • Reduces air pollution by 20% • Reduces mining waste by 80% • Reduces water use by 50% • Saves 9 gallon of fuel oil per ton

2.2 European Recycling Practices

Recycling is a global issue that each country handles in a different way. About 60 percent of all household waste is considered to be recyclable, and the European Union has been on the forefront of developing programs for recycling these goods. Switzerland is one of the leading countries in recycling. The government ties their efforts directly to the economy. Stickers, costing an equivalent to two U.S. dollars, are required for all trash bags. Glass, paper, and plastic are picked up monthly for free by government contractors. Local deposit locations are also available in supermarkets for tin, batteries, and liquid chemicals. With this system in place, the less trash a person generates, the less money he has to spend disposing it. (Foulke, 2006)

Denmark is dubbed one of Europe's "greenest" countries. The country's recycling standards have been set over the years by common polices coming from the primary and local governments. For example, one method employed by the government was the creation of jobs in the waste sorting industry; more than 10,000 Danes are in the waste management business. This act benefited both the economy and the waste industry. In 2003, figures showed that 31 percent of waste was recycled, 62 percent incinerated, and only 6 percent went to landfills. The only draw back to Denmark's recycling practices is that most of the country's recyclables have to be sent abroad to be processed due to their lack recycling plants. (Foulke, 2006)

Germany takes the idea of curb-side recycling to a superior level compared to the U.S. By law, residents are required to have five separate bins for trash disposal. The bins are color coded to avoid any confusion: yellow for packing material, blue for paper and

cardboard, clear for glass, green for left over food and plant waste, and a black bin for everything else. They must also take batteries and chemicals to a special recycling center. Statistics show that over 90 percent of Germans willingly sort their rubbish on a regular basis. (Foulke, 2006)

In Italy, recycling is determined by region. Many of the regions have hefty fines for anyone who does not separate their trash for recycling. In Rome, the government supplies bins for household waste, paper, and plastic that are picked up on a weekly basis. In southern Italy, it is apparently so profitable to recycle, that local crime lords control most of the waste management system. (Foulke, 2006)

Many countries in the European Union have developed successful recycling programs. Table 2.2 shows a breakdown of glass container, steel, and aluminum can recycling for various countries in the EU. Figure 2.2 shows where waste is deposited for various countries in the EU. Despite the EU's success with recycling, the region is still striving to improve their overall recycling capabilities. On May 19th 2003, the Commission to the Council of the European Union submitted a report to the European Parliament on waste legislation. It ranked the entire continent's waste management from 1998 to 2003 as "not yet satisfactory". In 2004, only 26 percent of domestic waste in the European Union was recycled, which varied greatly from country to country (from 8 percent to 63 percent). This was concerning, causing the Commission to release the "Thematic Strategy on the prevention and recycling of Waste." (Wallstrom, 2004)

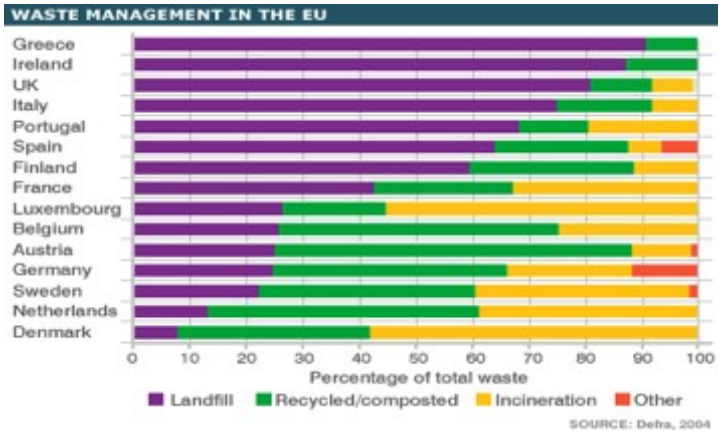
The "Thematic Strategy on the Prevention and Recycling of Waste" is a strategy set for the European Union for improving waste management. The main goal is to reduce

the negative impacts on the environment caused by the production and disposal of goods in Europe. All waste is considered to be a pollutant as well as a potential resource for

Table 2.2 European Recycling Rates for 2003

	Annual Recycling Rates		
Country	**Glass Containers (2003)**	**Steel (2003)**	**Aluminum Cans (2002)**
Switzerland	93%	66%	89%
Netherlands	86%	78%	-
Austria	84%	75%	50%
Sweden	84%	62%	87%
Norway	83%	59%	80%
Germany	81%	80%	86%
Finland	78%	-	84%
Denmark	63%	-	-
France	55%	47%	19%
Portugal	42%	-	-
Italy	41%	-	-
Spain	40%	32%	21%
Ireland	35%	-	-
UK	25%	30%	38%
Belgium	-	70%	-
Luxembourg	-	69%	-
Benelux	-	-	66%

(Graham 2005)



(Foulk, 2005)

Figure 2.2 Waste Management in the EU

materials. Members of the Union must regulate all waste from major corporations within their countries. The Union has mandated that certain levels of recycled materials must be used to produce new products. The required amount of recycled material is determined by what product is produced. These same corporations have also been given a cap on what amount of non-recyclable solid waste they may produce. (Wallstrom, 2004)

This strategy aims to both limit waste and improve the environment. Certain materials are considered "non-recyclable" if recycling the material causes a designated amount of pollution. Each targeted recyclable material is evaluated for long term effects on the environment, taking into account all options for recycling the material. Since the main goal is to reduce the impact on the environment, every stage of a product's life, from production to disposal, has been evaluated. The European Union has released a report of "eco-design products" which outlines what they believe is the safest way to mass produce products while reducing or eliminating harm to the environment. The goal of the plan was to make sure corporations were able to produce the best quality of product while minimizing the harmful effects on the environment. With this plan

corporations would be able to fall within regulation of the "Thematic Strategy on the Prevention and Recycling of Waste." (Wallstrom, 2004)

All products are considered to be waste at some point. As of the end of 2006, 49 percent of waste in Europe was disposed of in landfills, and 33 percent of waste was recycled. Although the EU has seen a rise in recycling, the amount of waste that is disposed of in landfills remained constant. In 2008, the European Union hopes to have enough information to amend the "Thematic Strategy on the Prevention and Recycling of Waste" so that they are not only recycling more but are also producing less waste. (Wallstrom, 2004)

The widespread recycling regulations found in the European Union are a positive step towards effective and successful waste reduction and resource conservation. Each European country, either on their own or within the European Union, has developed many ways to help reduce disposable waste. Many of the programs that are already in effect are years ahead of the United States. The EU serves as a positive model for developing national recycling regulations for the United States. We must look at other countries to help guide and model our own policies on waste management. As a leader in science and technology, WPI has the ability to help develop these policies in the US by setting a standard for others to follow. As more and more communities and organizations follow suite, recycling programs will develop and spread, and consequently, legislation will be put into place to secure and maintain these programs.

2.3 United States Recycling Practices

Waste management and recycling practices have come a long way in the United States since the nation's early years. In the 17th and 18th centuries, the United States had little to no form of waste management. The major contributors of waste in those times were household garbage and animal feces which littered the streets. One of the first ordinances enacted to mange waste was created by the Corporation of Georgetown in 1795. This ordinance prohibited garbage from being dumped on the street and prevented waste from being stored on private property. By the mid-1800s America's major cities were filthy and a call for a public waste removal system was made by public health officials. First attempts at waste management included refuse removal to open area dumps, towing garbage on scows into the ocean, and converting "animal carcasses, meat by-products, and other waste food products (Pichtel, 2005)" into raw materials for industrial uses at locations known as 'disposes.' At the dawn of the 20th century, more sophisticated waste collection systems began to emerge, and by 1930 nearly all major American cities implemented some form of waste collection. New York City was at the forefront of waste collection in America, utilizing incineration, encouraging sorting techniques within homes and businesses, and removing reusable goods and extracting chemicals from refuse for profit. As a result of the city's regular trash removal, public health improved drastically. The end of World War II sparked the development of our consumer-based society, causing a rise of waste production in the United States. Waste production had increased from 88 million tons in 1960 to 229 million tons in 1999. This latter figure translates to 2.1 kilograms of waste per person per day compared to approximately 0.23 kilograms of garbage per capita per day in 1916. The increase in

refuse has created a need for more effective disposal methods and regulation. (Pichtel, 2005)

After 1910, waste incinerators became wide spread in America. While incinerators were an effective way of reducing trash volume and producing heat to be used as energy, they often faced design problems and economic justification. Another method used by industry was reduction in which garbage was heated to allow for the extraction of usable materials. By the 1960s, incinerators were often found inside apartment complexes and burned a variety of trash resulting in widespread air pollution. It wasn't until 1967 that the Air Quality Act was introduced and controls were put on air emissions. Consequently, the restrictions caused many facilities that could not keep up with the Act to shut down; However, an energy crisis in the 1970s caused facilities to reemerge with technology able to harvest energy from burning garbage. (Pichtel, 2005)

Up until the 1950s, open-pit dumps were commonly used, attracting seagulls and insects and creating unpleasant odors, smoke, and noise. Consideration of the location of a dump and its proximity to water supplies was rarely taken. Sanitary landfills were introduced in the 1950s which involved creating thin layers of trash that were covered with soil at the end of each work day. While this alleviated some problems, the issue of water contamination and public health was not addressed. Growing public concern in the 1970s finally lead to federal regulations that regulated items such as landfill liners, covering soils, and proximity to the groundwater table. Today, the number of landfill sites has significantly dropped, “from about 20,000 in 1979 to 2,216 in 1999 (Pichtel, 2005).”

Early forms of recycling and reuse took place in the early 1800s when people known as "rag pickers" rummaged through dumps for valuable materials that could be sold. Between the 1800s and World War I, garbage was often fed to pigs. Unfortunately, this caused disease amongst the animals which was spread to humans in undercooked meat. The practice was regulated in the 1950s after an outbreak. Plant materials and animal excrement was often reused as fertilizers for agricultural land. In 1898, New York opened the first Materials Recovery Facility (MRF) in which nearly 37 percent of the City's waste was recovered for reuse. Generally speaking, Europe was ahead of America in its recycling practices, with German households required to sort items including "rags, paper, bottles, bones, rabbit skins, iron, and other metals (Pichtel, 2005)" in 1939. Collection drives for items such as paper were run by the Boy Scouts of America before the start of World War II, and collection through these drives increased as demand for recyclable goods increased during the war. In the 1960s, recycling became more prominent due to growing environmental awareness. Most recyclables were separated from the waste stream but unfortunately ended up in landfills due to a lack of market for the materials. Increased public interest in the environment and health concerns lead to more demand for recycling in the 1980s and spurred a market for recycled products. On a national and state level there exist guidelines for reducing waste and purchasing recyclable materials. Many municipalities have MRFs and recycling programs in order to reduce both the amount of trash deposited in landfills and its cost of dumping. Recycling is beginning to have an impact in the United States, with 28 percent of MSW recycled in 1999 compared to 16 percent in 1990 and just 10 percent in 1980. (Pichtel, 2005)

Currently, there is a limited level of regulation regarding recycling and reuse. The majority of federal mandates focus on other forms of waste management and their corresponding environmental impacts. The Resources Recovery Act of 1970 attempts to focus on energy and material recovery from solid wastes and "requires annual reports from the U.S. EPA on methods of promoting recycling and reducing overall generation of solid waste (Pichtel, 2005)." The Resource Conservation and Recovery Act of 1976 also encourages the EPA to promote recycling, with mandates in line that require federal agencies to purchase recycled materials. The Comprehensive Procurement Guidelines (CPG) and Recovered Materials Advisory Notices (RMAN) outline the requirements set for these federal agencies. Unfortunately, even with these guidelines the demand for recycled materials in industry is currently small. While the amount of recovered recyclable materials has increased drastically, some of the costs required to process the materials is not economically beneficial to companies, causing their demand to be small. Without economic incentives or demand for recycled goods from consumers, only a portion of collected recyclables becomes reused. It is important for WPI to develop a successful recycling program that helps propel and develop these minimal regulations already in place by setting an example. (Pichtel, 2005)

2.4 Corporate Abuse of Recycling

A public urge for recycling has spawned Trans-National Corporations (TNCs) to develop programs aimed at corporate responsibility. Unfortunately, many of these programs dating as far back as the 1980s have a reputation for failure and public deception.

In 1988, Mobile Corporation's popular Hefty Brand Bags were marketed as biodegradable, despite a substantial lack of evidence. In 1990, seven states filed lawsuits against the company, and in 1991 Mobile Corporation settled in a $165,000 deal. The damage Mobile Corporation has done goes beyond false advertising. A Greenpeace investigation of Mobile reports that plastic bags sent to Indonesia for recycling were actually thrown away. The manager of the plant in Indonesia estimated that nearly 40 percent of all plastics exported to his plant were thrown away. In a similar case with plastics company Solvay, plastic bottles collected from the public for recycling as well as the company's PVC waste was landfilled in Jemepee-sur-Sambre, Belgium. Even Browning-Ferris Industries (BFI), a well known waste removal company, has exported items intended for recycling to foreign nations. Hong Kong, Indonesia, and the Philippines commonly receive U.S. plastic exports. Countries in Africa, Latin American, Central and Eastern Europe, and the Caribbean have been known to receive wastes intended for recycling. Often these items are recycled under unacceptable working conditions or are deposited in landfills. (Greer, 1996)

For example, in 2002 the Basel Action Network reported that 50 to 80 percent of U.S. electronics being collected for recycling were sent to developing nations such as China, India, and Pakistan, where the items were "disassembled and recycled under largely unregulated, unhealthy conditions (Flynn, 2005)." Some U.S. companies have even donated or sold unusable electronics to developing nations in order to avoid the cost of recycling the items themselves. Nigeria has been a victim of this practice. According to the Basel Action Network's 2002 report, an estimated 400,000 computers are sent to the country each month with up to 75 percent of them being unusable and not

economically feasible for repair or resale. Since Nigeria has no electronics recycling system, the computers as well as other unusable electronics end up in landfills, posing a threat to both human health and the environment because of their toxic components. Electronic devices typically contain lead, flame-retardants, and cadmium. (Flynn, 2005)

In 1989 the Basel Convention, ran under the United Nations Environmental Programme, was drafted in order to provide guidelines for international transportation of hazardous materials, "developed criteria for environmentally sound management, (Introduction, 2007)" created a system of written consent, and aims to keep wastes as close to their origin as possible. Future development of the Convention hopes to achieve "full implementation and enforcement of treaty commitments (Introduction, 2007)," reduction of hazardous waste production, use of cleaner technologies, deterring illegal trafficking of hazardous wastes, and training. Control measures developed by the Convention require written notification and documentation of wastes. Most recently in 2004, the Convention released a statement calling for "a fundamental shift in emphasis from remedial measures to preventive measures such as reduction at source, reuse, recycling and recovery (Introduction, par. 13)."

There has been a considerable amount of debate over the Basel Convention. The United States has signed the Convention but not ratified it (Chapter, 2006). Due to this, the country cannot trade wastes "with Basel Parties without a separate and equivalent bilateral or multilateral agreement (Chapter V, 2006)." The Basel Ban was passed in 1998 by a group of developing countries which prevented the 29 wealthiest countries of the Organization of Economic Cooperation and Development (OECD) to trade with non-

OECD members to prevent developing nations from being taken advantage of (What is the Basil Ban, 2007).

Finding a company that responsibly handles WPI's recyclable goods is an important part of having a successful recycling program. Choosing a company without knowing how our recycled goods are handled or where they end up can negate all of our efforts to recycle in the first place. It is important to research a company's history and if they have been involved in any irresponsible practices so that we can make an informed decision about which company will best serve us.

2.5 Recycling in Worcester, Massachusetts

The city of Worcester is currently working hard to promote recycling. "Keep Worcester Clean" is the slogan of the Worcester Public Works Department's new citywide cleaning effort. The city regularly collects recyclables including newspapers, paper waste, plastics, glasses, and motor oil. The city, along with Waste Management Inc., provides residents with affordable home pick up of larger recyclables such as electronics and chemicals. Over the past couple of years, the city has also opened up many free recycling centers. The city has budgeted over 2 million dollars for waste and recycling programs for the 2008 year (O'Brien 2007).

Over the past ten years, the city has had problems with overflowing landfills. In 1994 the city's overall waste reduction was about 15 percent. During the month of November 1995 Mayor Elizabeth Smith of Worcester decided to revamp the city's recycling program into what it is today. The Mayor along with City Council implemented a program in which residents use a pay-as-you-throw trash system.

Residents were required to buy fifty cent, fifteen gallon trash bags to throw all trash in. The city began to collect more recyclables such as paper, plastic, and scrap metal at the curb for free while other solid waste was picked up for a fee. The city also began collecting yard debris separately, and began to dump this waste at specialized facilities. At first the average household cost for waste management was about $75 per month but quickly fell to around $27 per month. The city of Worcester also has stated that bottle redemption within the city has reached 75 percent. The city also promotes home composting, providing free classes twice a year that teach how to perform backyard composting. Composting bins are available from the DPW. About 457 have been sold to date. (Corvello, 2004)

Having cost directly related to the amount of waste disposed helped reduce the amount of recyclable wastes being thrown away from 44 percent in 1995 to 15 percent in 1999. Currently all recycled waste is brought to Transcyclery in the town of Auburn. There, all waste is sorted into separate fiber and container streams which each section of the facility breaks down and processes. Trash bag sales help fund over half of the cost to run the recycling program in the City. One of the City's main concerns is the lack of education for the 40,000 college students in the area. (Corvello, 2004)

The State of Massachusetts has also affected the City in a great way. On January 17th 1983, the Massachusetts Department of Environmental Protection passed the State bottle deposit bill. This forced all consumers to pay a five-cent deposit on all bottles for carbonated beverages, mineral water, and malt beverages. In order to redeem the deposit, consumers must bring all containers to a recycling facility. This helped the state raise recycling from 24 percent in 1983 to nearly 43 percent in 2002. All unclaimed deposits

go into the Massachusetts Environmental Fund. Both the City of Worcester and the State of Massachusetts help promote recycling by educating all elementary school students about recycling and the City's program. (Corvello, 2004)

Currently the City Council is working on a plan called the Climate Action Plan, which reduces greenhouse gas emissions and promotes clean energy. The Council intends to hire a part-time Energy Manager to oversee the Plan. The Energy Manger will put together a task force and devise a plan that will hopefully be in effect by the Fall of 2007. Among many other goals, the task force will be developing and executing recycling plans for all of Worcester's public schools by the end of 2008. (Corvello, 2007)

Even with all the steps that have been made to improve recycling throughout the City of Worcester, one major population in town hasn't been reached: college students. While the City promotes recycling within its public schools and informs all residents about recycling services offered, the colleges and universities in town are left to develop their own programs. Unfortunately, this leaves a considerable amount of college students uninformed about the services provided by the City. Higher institutions of learning and the city of Worcester would benefit by working together to better inform students of their waste disposal options as well as helping improve one another's recycling programs.

2.6 University Recycling Programs

2.6.1 University of Colorado at Boulder

The University of Colorado at Boulder boasts one of the oldest and most prominent campus recycling programs in the country. First implemented in 1976, the

program has grown into a collaboration between the University's Student Union and the administration's Facilities Management Department. (CU Recycling, 2005)

The University's recycling program is largely maintained by students. Employment opportunities are provided to students through work study, academic credit, and on a volunteer basis, with a majority of positions given to work study students. The Student Union's Environmental Center provides training to employees, organizes campus promotions of the recycling program, processes recyclables, and oversees University contracts related to the recycling program. The Department of Housing provides an infrastructure for the program, with recycling containers throughout the dormitories and throughout campus. (CU Recycling, 2005)

An exceptionally large variety of materials, shown in Table 2.3, can enter the campus's recycling stream. In addition to this plethora of items, the program also provides special collection for items such as diskettes, transparencies, tyvek, and toner cartridges. (CU Recycling, 2005)

Table 2.3 University of Colorado's Accepted Recyclable Materials

<table>
<tr><td>Newspaper</td><td>Magazines</td></tr>
<tr><td>Newsprint</td><td>Phonebooks</td></tr>
<tr><td>Ad Inserts</td><td>Paperboard</td></tr>
<tr><td>Commingled Containers: Aluminum, Steel, and Tin Cans, Glass Bottles and Jars, #1 and #2 Plastic Bottles and Jars, Paper Milk Cartons, Drink Boxes, Empty Aerosol Cans, Clean Aluminum Foil, Metal Lids and Caps</td><td rowspan="2">Office Waste: Paper (Computer, Copy, Fax, Notebook, Notepad, Looseleaf, White Pastel), Carbonless Forms, File Folders, Index and Greeting Cards, Brochures, Ads and Pamphlets, Envelopes, Junk Mail, Stationary, Letters, Letterhead, Blueprints, Adding Machine Tape, White Ream Wrappers</td></tr>
<tr><td>Corrugated Cardboard: Flattened Pizza Boxes, Brown Paper Grocery Bags, Brown/Orange Envelopes</td></tr>
</table>

Educational materials are provided to the campus community to remind them of the vast amount of recyclable products. The Environmental Center provides signage near collection bins in order to assist faculty, staff, and students in determining which items are permissible. Examples of such signs can be found Appendix A. Campus education goes beyond signs. The recycling staff offers to speak to any group about the program and answer any questions. The 'Green Team' provides information to off-campus students. The 'Save the World Action Team' (S.W.A.T.) can be found around campus dressed up in capes and running a public, interactive, educational campaign that promotes the trash collection areas. Tours of the school's Intermediate Processing Facility are available. The Environmental Center also provides assistance in organizing trash and recyclables collection at planned events. (CU Recycling, 2005)

Collection bins for many of the aforementioned recyclables are located throughout campus including the residence hall rooms, resident hall loading docks, dumpsters, computer, copy and mail rooms, offices, and central locations. There is also a drop off center at the Intermediate Processing Facility which accepts all items. (CU Recycling, 2005)

The Intermediate Processing Facility is the hub of the recycling program, where materials are placed onto a conveyor belt, sorted for contaminated and nonrecyclable items, weighed and then packed on a truck bed to be sent to Eco-cycle, the University's recycling company. In a single day, the Intermediate Processing Facility can pack up to 10,000 pounds of material; a sign that the University of Colorado's recycling program is a success. (CU Recycling, 2005)

A key element in any recycling program is educating the campus of the importance of recycling and what recycling facilities are available. The University of Colorado's has done an excellent job in doing so. They have a variety of groups that keep the campus educated in a fun and positive manner and have clear signage that informs students, faculty, and staff of recycling procedures. This is an important aspect to incorporate into WPI's campus-wide program to ensure its success.

2.6.2 University of Oregon

The University of Oregon's recycling program has received a great deal of recognition for its success. First developed in 1990, it has since received 14 awards and honors, most notably the EPA's University Partner of the Year Award in 2005 and the National Recycling Coalition Recycler of the Year: Innovative Recycling Process for Zerowaste Events in 2002. (University of Oregon Campus Recycling Program, 2006)

Both students and full-time employees, working shifts Monday through Friday between 7:30am and 6:00pm, staff the University's program. For a school of approximately 20,000 students, it takes 450 scheduled student work hours to successfully cover the campus. Students helping the program work a minimum of 6 to 8 hours each week and a maximum of 20 hours per week while school is in session. Students are able to work for the program under a variety of conditions including work study, tech-fee, internship credit, and on a volunteer basis. Students are hired in a variety of positions including paper routes, paper sorting, ROSE recycling, housing recycling, bicycle collection routes, van routes, Program Administrative Assistant, and Student Events Coordinator. Students are arranged into two man crews that collect recyclables

throughout the campus. New workers receive extensive training in a variety of programs: "Safe Lifting and Back Safety, Stretch Program, Hazardous Materials Communication, Hazardous Jobs and Equipment, Personal Protective Equipment, Initial Driver Guidelines, and Emergency Medical Plan" (University of Oregon Campus Recycling Program, 2006).

A variety of collection containers are available throughout the campus and are sized and styled based on their location, aesthetic requirements, fire requirements, and necessity for leakproof linings/bags. Many of these containers have been purchased from Behrends, local supply stores, Busch Systems, The Bag Connection, Columbia Corrugated Box Co., and DeWald Northwest. Outside funding has helped acquire these containers. In the past, private donors have donated half of the school's outside collection containers as well as a trailer used for hauling materials. The City of Eugene partnered with the University to write a grant for funding which was helpful in purchasing some of the University's containers. Private and public grants have been "burdensome" to write; However, students participating in internships and classes have been able to take the time to write them for the school's program. (University of Oregon Campus Recycling Program, 2006)

The University tries to incorporate waste reduction in their vendor contacts to help assist the recycling program. Vendors must pay the University $500 per month to help pay for the expenses attributed to having a recycling bin next to the vending machines and must also pay $1,000 per year for bin purchase and maintenance. Due to the University's suggestions, their office supply vendor voluntarily carries products made out of recycled materials, ships goods weekly instead of daily, has reduced its amount of

packaging involved in shipping, and uses reusable shipping bags. Their cardboard collection contract is bid on every 5 years to be either paid for or bought depending on its market value. (University of Oregon Campus Recycling Program, 2006)

It is important to recognize that recyclables are generated from multiple facets of campus operations, and that the responsibility to manage this waste does not have to fall solely on the school. The University of Oregon's ability to incorporate sustainable practices into its outside contracts helps further reach its goal of waste reduction, as well as promotes sustainability in the surrounding community. WPI should evaluate each of its outside contracts to see where sustainable improvements can be made and then propose these improvements to its partners.

2.6.3 Clark University

Clark University, located in Worcester, Massachusetts, has a well-organized recycling program located right in WPI's neighborhood. First started on a part-time basis in 1990 by two Clark University students, the program has since developed into a successful operation, collecting a variety of Clark University's recyclables. (History, 2007)

The program is run by Dave Schmidt, the full-time Campus Sustainability Coordinator in charge of "recycling, energy conservation, and other campus sustainability issues" (History, 2007). During the school year the program is staffed by work study students and during the summer is staffed by a smaller group of non-work study students. (Recycling Center, 2007)

The Recycling Center is housed in its own building at 5 Hawthorne Street. The Recycling Center is primarily in charge of collecting paper products and bottles and cans

for recycling. The Physical Plant, staffed by non-student workers, is in charge of collecting fluorescent lightbulbs, yard and landscaping wastes, waste oils and mechanical fluids, computer equipment, scrap metal, and food grease for recycling purposes (Physical Plant Recycles, 2007). Clark University contracts with the Institute Recycling Network (IRN) for the removal of their recyclables. At one point in time the Recycling Center had a room for collecting reusable items such as "used books, office supplies, Styrofoam packing peanuts, and other second hand items" (Frequently Asked Questions, 2007); However, in 1998 this reuse collection program was eliminated because of a need for space. (Frequently Asked Questions, 2007)

Recyclables are collected in one of three 40 or 50 gallon containers: yellow containers hold plastic, glass, and tin/aluminum cans and bottles, and green and grey containers hold paper and corrugated cardboard. Smaller, desk-side recycling bins are also available. Departments have the option to supply their own bins to suit their needs. Most containers are collected on a weekly pick-up schedule. If a bin is full before collection, a call can be placed to the Recycling Center for early pick-up. The Recycling Center will also provide additional bins, answer questions, and save cardboard boxes upon request. (Frequently Asked Questions, 2007)

The Recycling Center has had to deal with a few problems that many recycling programs commonly face. In 1997, paper recycling containers had to be removed from the dorms because students were contaminating the receptacles with trash. In 2004, the containers were reintroduced to the dormitories with clear guidelines on what can be deposited. These guidelines are shown in Appendix B. While the guidelines have helped, contamination remains an issue. Another issue Clark faces is limited plastic collection. At

this point in time the University only collects #1 and #2 plastic bottles because of its availability and market demand. All other types plastics are not cost-effective or pose collection issues for the University. Fortunately, "Clark continues to explore opportunities to expand the types of items that are recyclable on campus." (Frequently Asked Questions, 2007)

An important component to Clark University's recycling program is their full time recycling coordinator. Not only does he manage the recycling program, but oversees all issues related to sustainability on campus. This position can play an important and valuable role in any recycling program. Having someone oversee all activities related to sustainability ensures a consistent and thorough recycling program that is properly monitored as well as coordinated with the overall environmental goals of the campus. Such a position should be incorporated into WPI's recycling program to ensure the operation of a successful program.

2.6.4 Colleges of the Worcester Consortium

Table 2.4 lists the 13 colleges and universities who are members of the Worcester Consortium, of which WPI is a member, and whether or not these schools have a recycling program for paper goods and cans and bottles. WPI appears to have a less developed recycling program compared to a majority of the responding fellow academic institutions in Table 2.4. In the long term, not having an appropriate collection program for bottles and cans while the University's neighboring schools have a program in place will impact WPI's credibility on environmental affairs and its reputation as a progressive and adaptive institution that is in tune with contemporary problems.

Table 2.4 Recycling Support for Worcester Consortium Colleges and Universities

College or University	Recycling Program Supports Collection of Cardboard and Paper Products	Recycling Program Supports Collection of Cans and Bottles
Anna Maria College	In Development	In Development
Assumption College	Yes	Yes
Atlantic Union College	No Response	No Response
Becker College	No Response	No Response
Clark University	Yes	Yes
College of the Holy Cross	Yes	Yes
Cummings School of Veterinary Medicine	No Response	No Response
Mass. College of Pharmacy & Health Sciences	Yes	Partially – staff choose to set up bins and deposit cans personally
Nichols College	Yes	Yes
Quinsigamond Community College	No Response	No Response
UMass Medical School	Yes	Partially – departments choose to set up bins and deposit cans personally
Worcester State College	No Response	No Response
Worcester Polytechnic Institute	Yes	No

*No Response indicates that the college was unavailable to provide data after the facilities department was contacted at least twice via telephone and a voicemail was left (if possible).

3 Worcester Polytechnic Institute

Worcester Polytechnic Institute recognizes the importance of recycling on both a local and global scale. Over the past fifteen years the recycling program has slowly grown and is currently trying to find ways to improve itself.

3.1 WPI Recycling Policy

Worcester Polytechnic Institute currently has a system in place for the collection of office mix paper, cardboard, metals, electronics, and batteries. In academic buildings, collection containers are available for all types of paper and other office supplies. Every building also contains brown bins for the collection of recyclable cardboard. Scrape metal and electronics on campus are dealt with on a case by case basis and are picked up by WPI Facilities by scheduling an appointment. The school has also set up used and dead battery collection bins around campus that are collected on a monthly basis. Battery bins are placed mainly in labs and high traffic areas of campus (WPI Department of Facilities, 2007).

Currently there is an office mix compactor located behind Fuller Hall, a cardboard compactor located behind the library, and a commingled compactor at Gateway Park. Electronic recyclables are stored in the basement of Fuller. Since WPI does not currently have a place to store scrape metal, it is brought directly to a local scrape yard by the WPI Department of Facilities (Pellerin, 2007).

Currently, unless faculty, staff, and students have taken it upon themselves to properly recycle their cans and bottles, they are disposed of in the trash by the custodial staff regardless if the cans and bottles have been separated from the trash. A number of

students and the custodial staff do take it upon themselves to make sure these recyclables are properly disposed of and on there own time take recyclables to off campus sites for processing. The money made from can and bottle deposits is considered a bonus for custodial staff. (Pellerin, 2007)

WPI works closely with the Institute Recycling Network (IRN) to dispose of recyclables on campus. Most of the colleges in Worcester use the IRN to dispose their recyclable waste (WPI Department of Facilities, 2007). The IRN works with over 125 schools and hospitals in the New England area. Their goal is to provide an organization with a single place to go to with all of its recyclable waste. They handle all outside contractors for an organization and schedule waste pick up times. The IRN negotiates all prices and processing fees and provides accounting reports for each of their clients. Clients can also buy the recycled goods at a lower cost straight from the company. The IRN has also donated a large portion of its recycled scrape metal and recycled furniture to Hurricane Katrina relief efforts (Pelillo, 2007). The cost to be a member of the IRN is $700 per year. Fifteen percent of the money generated from selling the school's recyclables goes to the IRN as a fee, with the other 85 percent directly going back to the school. This is then figured into the Department of Facilities budget (Pellerin, 2007).

Table 3.1 shows the tonnage of recyclable materials produced at WPI during the 2006-2007 academic year. By selling back the school's electronics, office mix paper, cardboard, and furniture in the 2006-2007 academic year, the Department of Facilities made back approximately $2,500 in revenue. Table 3.2 provides the number of bottles and cans Chartwells, the University's food provider, generated over a three and a half month period ranging from September 1, 2007 to December 18, 2007 and an annual

approximation of their total bottle and can generation based on this data (Wilder, 2007). Over the span of an academic year, it is estimated that Charwells will generate approximately 12,946 metal cans and 33,587 plastic and glass bottles. These numbers alone justify the expansion of WPI's recycling program, and don't take into account bottles and cans generated through vending machines, laundry detergent bottles, and outside sources.

Table 3.1 WPI's Tonnage of Recyclable Materials, 2006-2007 Academic Year

Material	Tonnage
Mixed Electronics	13.63 Tons
Mixed Office Paper	45.06 Tons
Cardboard	40.08 Tons
Surplus Furniture	16.12 Tons
Universal Waste	0.43 Tons
Metal	17.14 Tons
Trash	629.15 Tons

Table 3.2 Chartwells Bottle and Can Generation, 09/01/2007 through 12/18/2007 and Annual Estimation

Dining Location	Number of Metal Cans	Number of Plastic and Glass Bottles
Campus Center	12	154
Catering Services	1,140	989
Founders	548	886
Morgan	2,166	8,001
Total (9/01/07-12/18/07):	**3,866**	**10,030**
Estimated Annual Total:	**12,946**	**33,587**

Recently the new Bartlett Center has been constructed using Leadership in Energy and Environmental Design (LEED) standards which incorporate recycling into building design. The Center has been certified as a Green Building by the U.S. Green Building Council. LEED guidelines are followed during design and construction, which result in improvement of air and water quality, reduction in solid wastes, conservation of natural

recourses by using recycled materials, and lower cost. The campus plans to have all new buildings built on campus LEED Certified. (Berkey, 2007)

3.2 Current Building Practices

WPI's recycling program was first implemented in 1994 in conjunction with an MQP that investigated which items on campus were being thrown away and could be recycled. The program has slowly grown since then. Tables 3.3, 3.4, 3.5, and 3.6 illustrate the current location of recycling containers on campus. Any can collection bins currently on campus are either deposited in the trash or taken by custodial staff and deposited as a bonus. In addition to these containers, smaller desk-side recycling bins for office mix items including computer paper, envelopes, newspaper, magazines, telephone books, card stock, file folders, and manila envelopes, are found in most offices and department lounges. These desk-side bins are emptied into larger 50 gallon bins by the custodians on a daily basis. When the 50 gallon bins are full, they are placed on the curbside for Facility Services to pick up. Figures 3.1, 3.2, 3.3, and 3.4 show a variety of the large 50 gallon bins on campus and their accompanying signs which indicate what materials can be deposited in them. The large, 50 gallon paper and cardboard bins located in the dormitories are also placed on the curb by custodial staff for pick up when full. Upon pick up, the materials are brought to their respective compactors, are compacted, and await pick up from the IRN. Figure 3.5 shows a flow diagram summarizing this collection process. Two dedicated, full time Facility staff members work the recycling program. They are the only staff members with keys to the recycling compactors; this

helps prevent other custodial staff from accidentally depositing trash into the recycling compactors. (Pellerin, 2007)

While there is a fairly consistent system for office mix and cardboard collection on campus, there currently exists no consistent, campus wide collection system for bottles and cans. Gateway Park is the first location on campus to have a commingled recycling system and a commingled compactor on site. The commingled collection system accepts all paper, plastic, and metals, excluding food, food wastes, and food containers. Unfortunately, sell back of these compacted commingled goods generates less revenue because they are not sorted. Despite this setback, an outstanding benefit of the commingled collection system is that there is less confusion over which items can be deposited into receptacles. The simplicity of commingled collection makes it a good potential candidate for the new, campus wide recycling program. (Pellerin, 2007)

Table 3.3 Battery Bin Locations (WPI, 2007)

Building	Bin Location
Air Force ROTC	37 Institute Road
Alumni Gym	Equipment room
Atwater Kent	Elect. shop, room 112
Boynton Hall	Duplicating office, basement level
Campus Police	35 Dean Street
Goddard Hall	Stockroom, room 114
Higgins Lab	Machine shop, room 008
Kaven Hall	Environmental lab, room 010
Olin Hall	Prep lab, room 109
Salisbury Lab	Prep lab, room 228
Washburn Shops	Machine shop, room 107
Campus Center	Mail Services

Table 3.4 Number of Large Collection Bins Located in Hallways of Academic Buildings (as of April, 2007)

Building Name	Level	# Paper Bins	# Cardboard Bins	# Can Bins*	Other/Notes
Atwater Kent Laboratories	Basement	1	1	0	
	Level 1	3	0	0	
	Level 2	0	0	0	
	Level 3	1	0	0	
Fuller Laboratories	Sub-basement	0	0	0	Computer Waste Drop-off
	Basement	3	0	0	
	Level 1	2	0	0	
	Level 2	3	0	0	
	Level 3	1	0	0	
Kaven Hall	Basement	0	0	0	
	Level 1	2	0	0	
	Level 2	1	0	0	
Olin Hall	Basement	2	1	0	
	Level 1	0	0	0	
	Level 2	1	1	0	
	Level 3	0	0	0	
Goddard Hall	Basement	0	0	0	
	Level 1	3	2	0	Chem waste storage
	Level 2	0	0	0	
	Level 3	1	0	0	
Stratton Hall	Basement	2	0	0	
	Level 1	1	0	0	
	Level 2	0	0	0	
	Level 3	0	0	0	
Higgins Laboratories	Level 1	3	1	0	
	Level 2	1	0	0	
	Level 3	1	0	0	
Salisbury Laboratories	Basement	1	1	0	2 large open blue bins
	Level 1	1	0	0	
	Level 2	1	0	0	
	Level 3	1	0	0	
	Level 4	0	0	0	
Washburn Shops and Stoddard Laboratories	Basement	0	0	0	
	Level 1	0	0	0	
	Level 2	0	0	0	
	Level 3	2	0	0	

* Any can collection bins currently on campus are either deposited in the trash or taken by custodial staff and deposited as a bonus.

Table 3.5 Number of Large Collection Bins in Dormitories (as of April, 2007)

Building Name	Level	# Paper Bins	# Cardboard Bins	Location of Bins
Morgan Hall	Level 2	0	0	
	Level 3	1	1	Near bathrooms
	Level 4	0	0	
Daniels Hall	Level 2	0	0	
	Level 3	1	1	Next to elevator
	Level 4	0	0	
Sanford Riley	Level 1	1	1	Lounge
	Level 2	0	0	
	Level 3	1	1	Lounge
	Level 4	0	0	
Institute Hall	Level 1	0	0	
	Level 2	1	1	Center of hallway
	Level 3	0	0	
Stoddard Complex: Unit A	Level 1	1	1	Common area
	Level 2	0	0	
	Level 3	0	0	
Stoddard Complex: Unit B	Level 1	1	1	Common area
	Level 2	0	0	
	Level 3	0	0	
Stoddard Complex: Unit C	Level 1	1	1	Common area
	Level 2	0	0	
	Level 3	0	0	
Founders Hall	Level 1	1	1	Common area
	Level 2	0	0	
	Level 3	1	1	Common area
	Level 4	0	0	
25 Trowbridge	Level 1	1	1	Living room
	Level 2	0	0	
16 Elbridge/Healthy Alternatives House	Level 1	1	1	Living room
	Level 2	0	0	
	Level 3	0	0	
22 Schussler//World House	Level 1	1	1	Living room
	Level 2	0	0	
26 Hackfeld/Unity House	Level 1	1	1	Living room
	Level 2	0	0	
Ellsworth and Fuller Apartments	Must bring to loading dock at plant services			

Table 3.6 Number of Large Collection Bins Located in Hallways of Administrative and Recreational Buildings (as of April, 2007)

Building Name	Level	# Paper Bins	# Cardboard Bins	# Can Bins*	Other/Notes
Library	None - just small, blue, deskside paper bins scattered throughout				
Campus Center	Level 1	1	0	2	Battery collection
	Level 2	1	0	1	
	Level 3	1	0	0	
Higgins House	Level 1	0	0	0	
	Level 2	1	0	0	
	Porch	1	1	0	
Alden Memorial	Basement	0	0	0	
	Level 1	0	0	0	
	Level 2	1	0	0	
Bartlett Center	Level 1	1	0	0	
	Level 2	1	0	0	
Alumni Gym	Basement	0	0	0	
	Level 1	1	1	0	
Harrington Auditorium	Basement	1	1	0	
	Level 1	1	0	0	
Daniels Hall	Level 1	2	0	0	
Boynton Hall	Basement	3	0	0	
	Level 1	0	1	0	
	Level 2	0	1	0	
	Level 3	1	0	0	
Project Center & Career Development Center	Level 1	1	1	1	
	Level 2	0	0	0	

* Any can collection bins currently on campus are either deposited in the trash or taken by custodial staff and deposited as a bonus.

Figure 3.1 50 Gallon Paper Bin Lid with Sign

Figure 3.2 50 Gallon Paper Bin Profile, Located on the 1st Floor of the Campus Center

Figure 3.3 Sign Posted Explaining Acceptable Recyclable Matrials

Figure 3.4 Profile of 50 Gallon Cardboaindeerd and Recycling Bins

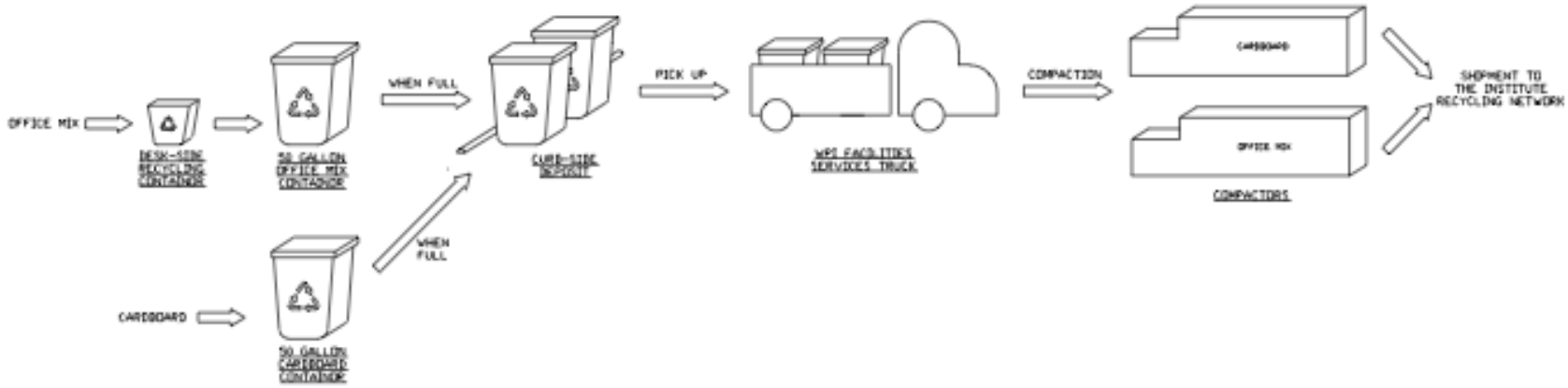


Figure 3.5 Current Method of Collecting Recyclable Goods on Campus

3.3 Administrative Support and Community Calls for Action

A variety of individuals from the Student Body as well as groups on campus have been actively discussing recycling on campus and support the development of a better recycling program at WPI that includes bottle and can collection. Terry Pellerin, Associate Director of Buildings and Events, explains that he has received numerous complaints from students wondering why custodial staff members were throwing away bottles and cans as well as students asking where they are supposed to deposit their bottles and cans (Pellerin, 2007).

Student groups such as The Residence Hall Council, Global Awareness of Environmental Activity (GAEA), and the Student Government Association have been trying to address the issue. Since August of 2007, the Residence Hall Council has been investigating ways to include more recycling in the dormitories. At this point in time, there are 50 gallon paper and cardboard recycling bins sparsely located in a minority of the dormitories. Ultimately, the Council would like to see paper, cardboard, and bottle and can collection in all of the dormitories. In November of 2007, the Council attended a regional conference held by the North East Affiliate of College and University Residence Halls which addressed how to provide leadership, diversity, community, and sustainability in residence halls (NEACURH Regional Conference, 2007). At the conference, whose theme was "Getting Our Region Geared toward Environmental Sustainability," the Council learned about a variety of programs that can be used to effectively encourage recycling in the dormitories and throughout campus. Two WPI attendees even won first place in an essay contest addressing how dormitories can be made more sustainable. Unfortunately, none of the programs the Council learned about can be run at WPI because of our lack of a solid program and unclear and wavering

support from the administration. The lack of clear and consistent administrative support has made it especially difficult to further pursue options for placing a recycling program in the dormitories. Residential Services has presented the Council with a few problems recycling bins may present, such as odor and pest control and collection methods. The Council has been unable to fully address these problems because there are too many varying viewpoints throughout the administration, making it difficult to obtain information and determine the best solution. The overall result has been extreme frustration, as the Residence Hall Council reports, "[We] want recycling in their [WPI's] buildings but we do not feel as though there is anything we as a group can do" (Trabucco, 2007).

GAEA, the environmental activism group on campus, has also made recycling on campus one of its priorities for the 2007-2008 academic year. Aside from their intentions this year, the club had previously assembled a petition during 2003 to 2006 with over 400 signatures from members of the WPI community demanding a better recycling program on campus. The petition can be found in Appendix C. In addition to this paper petition, a group consisting of 379 members as of November 8, 2007 on the popular social networking site Facebook has been established which demands a proper recycling program on campus. GAEA's goal is for WPI to not only commit to recycling, but to achieve a larger commitment to sustainability through the Campus Climate Challenge. The Challenge asks high schools and colleges to use 100% Clean Energy policies to help reduce pollution and green house gas emissions (About, The Campus Climate Challenge). (GAEA Meeting, 2007)

Finally, due to student demand the SGA assembled a committee in the Spring of 2007 to investigate the costs and details associated with running a recycling program and to provide a recommendation for how to do so. The committee began meeting in the Fall of 2007. The SGA saw a tremendous need for WPI to create a uniform recycling program because of its lack of aluminum, plastic, and glass collection on campus. (Hassett, 2007)

Dr. Dennis Berkey, President of Worcester Polytechnic Institute, is aware of the efforts being conducted on campus to achieve a successful recycling program. While he understands the environmental benefits and student demand for the program, he reminds us that, as with any program, the costs, practicality, and limitations must also be considered. For this reason, he supports all of the efforts currently being made. Dr. Berkey agrees that recycling is an important issue for WPI, and that implementation of a program falls into WPI's larger goal of incorporating sustainable practices into campus life. WPI has already taken the initiative to have its new buildings constructed with LEED certification. LEED stands for Leadership in Energy and Environmental Design, and WPI believes that it is the school's responsibility to be leaders in our community and incorporate sustainability into our new buildings. Dr. Berkey notes that recent changes in the administration, especially with the arrival of Alfredo DiMauro as Vice President for Facilities, have broadened WPI's perspective, brought fresh ideas for addressing recycling, and has led to the development of the Green Team. (Berkey, 2007)

The Green Team, formally known as the President's Task Force on Sustainability, was commissioned by the President in the Fall of 2007 to address issues relating to sustainability including energy use and climate change. The Green Team serves as a cross section of a variety of campus members by requiring one or more graduate student, one

or more undergraduate student, and one or more faculty member to serve on the Team. The Team is also required to have the Vice President of Marketing and Communication or his representative, the Vice President of Student Affairs and Campus Life, the Vice President of Facilities, the CFO, and Provost as members. Over the Fall 2007 semester the Team developed a plan for bottle and can collection on the WPI campus. This plan was developed in collaboration with Terry Pellerin, Associate Director of Buildings and Events, and his superior Alfredo DiMauro, who also serves on the Green Team. The Green Team's plan is explained in Section 4.1. (DiMauro, 2007)

With such a variety of support from both individuals and large groups on campus ranging from students to the administration, there is more than an adequate demand for the development of an expanded recycling program.

4 Options for Bottle and Can Collection at WPI

In order for WPI to run a successful recycling program, a clear and complete method for depositing, collecting, and selling our bottles and cans must be established.

4.1 The Green Team's Plan for Expansion

Over the Fall 2007 Semester, the Green Team has established what they consider the best plan for introducing bottle and can recycling to WPI. In their plan, new, large containers for bottle and can collection would be placed on all three floors of the Campus Center, in the entrance of all academic buildings, on every floor of the Residence Halls with elevators, and on the first floor of the Residence Halls without elevators. The Team is currently considering collection options for the apartments. Fred DiMauro estimates that the large containers would be emptied every three days. Collection dumpsters for commingled glass, plastic, and aluminum would be placed at the Campus Center, Morgan Hall, and Founders Hall to accommodate Chartwells, WPI's food provider who is the campus's major can and bottle producer. Custodians would be in charge of bringing the large bins to the dumpsters, while Chartwells staff would be responsible for bringing their recyclables to the dumpsters. Their estimated cost for buying new containers, leasing to own three dumpsters over three years, and hauling is $25,000 to $28,000. They hope that once this plan has been rolled out, it can be improved and expanded upon to better suit the campus. A student project group worked with the Green Team to create an informative website where anyone can learn about sustainability at WPI and how the recycling program is run, as well as provide input on the success and shortcomings of the program.

4.2 Collection Methods

The main objective is to collect all plastic, glass, and aluminum bottles and cans on campus. Bottles and cans can be collected in one of three ways: commingled single stream, commingled separate stream, or sorted stream.

4.2.1 Commingled Single Stream

Commingled single stream collection combines office mix with bottles and cans in one container. In the event single stream collection is used, the existing office mix collection bins would be used to accommodate bottles and cans in addition to office mix. Single stream bins should be placed in target areas that have a constant flow of recyclables. Lounges on campus, especially those with vending machines, each floor of every dormitory, and the campus center should have designated bins for collection. The apartments should receive medium sized collection bins. A large collection bin should be placed in the basement of Daniels near the entrance closest to the trash compactor to accommodate drop-off of the apartments' recyclables. The existing desk-side collection bins would be used for can and bottle collection as well as office mix. Much like what is currently done with the school's desk-side office mix containers located in faculty and staff offices, the single stream desk-side bins would be emptied daily into larger bins by custodial staff.

Similar to the University's current practices, when the large single stream bins are full they would be placed on the curb directly outside of the building they were collected in. The custodians would then load the bins into a WPI facilities truck which would then bring the materials to a compactor. The existing office mix compactor located behind Fuller Laboratories would be used as the commingled single stream compactor.

The advantage to commingled single stream collection is that it makes depositing recyclables easy for users. There is less confusion and thinking about which container a recyclable item belongs in and less time spent finding the appropriate container. The disadvantage to commingled single stream collection is the high cost associated with implementing this collection method at WPI. Considering the high volume of bottles and cans Chartwells generates, as shown in Table 3.2, a new custodial staff member would have to be hired and a new Facilities truck purchased in order to accommodate transferring Chartwells' recyclables to the compactor in addition to the remaining University's recyclables. Terry Pellerin estimates that cost to hire an additional custodian is $45,000 in annual salary and the operation costs of a truck is approximately $8,000 annually. Additionally, companies that purchase recycled goods offer less money for commingled recyclables compared to sorted recyclables. (Pellerin, 2007)

4.2.2 Commingled Separate Stream

Commingled separate stream collection separates office mix from commingled bottles and cans. In the event commingled separate stream collection is used, new collection bins for bottles and cans would be purchased. Bottle and can bins should be placed in target areas that have a constant flow of recyclables. Lounges on campus, especially those with vending machines, each floor of every dormitory, and the campus center should have designated bins for bottle and can collection. Additionally, each of these locations should receive office mix collection bins if they do not already have them. The apartments should receive medium sized collection bins for bottles and cans with a smaller desk-side bin placed inside the medium bin to accommodate office mix collection. Two large collection bins, one for office mix and one for bottles and cans, should be placed in the basement of Daniels near the entrance closest to the trash

compactor to accommodate drop-off of the apartments' recyclables. New desk-side collection bins should be purchased for can and bottle collection and placed in faculty and staff offices next to the existing desk-side office mix bins. Much like what is currently done with the school's desk-side office mix containers, the new bottle and can desk-side bins should be emptied daily into larger bins by the custodial staff. Alternatively, the existing desk-side office mix bins could be used to collect bottles and cans in addition to office mix, and the custodial staff could manually separate the office mix from the bottles and cans upon collection; However, this is less desirable to custodial staff, would likely require greater compensation, and increase the chance of office mix contamination from leftover food and drink.

Similar to the University's current practices, when the large bottle and can bins are full they would be placed on the curb directly outside of the building they were collected in. The custodians would then load the bins into a WPI facilities truck which would then bring the materials to a new dumpster for bottles and cans.

There are a variety of dumpster locations available. The Green Team proposed that dumpsters are located in the Campus Center parking lot, next to Morgan Hall, and next to Founders Hall. These locations are ideal because they are closest to Chartwells, the school's major bottle and can generator. Alternatively, a new dumpster could be located on campus behind the tennis courts. This location is ideal because it provides a close holding spot for bottles and cans while keeping the unsightly appearance of the compactor away from the main campus. One item of concern is the amount of noise the dumpster may produce. Fortunately, its use would primarily occur during regular daytime

business hours when noise would not be a problem for the surrounding tennis courts and residences.

In the event that only one dumpster is purchased to hold all of the University's cans and bottles, a new custodial staff member will have to be hired and a new truck will have to be purchased for hauling recyclables to accommodate the large amount of recyclables Chartwells produces, as shown in Table 3.2. However, if one dumpster is located at each of the dining locations, Chartwells' workers would be required to deposit their recyclables into the dumpsters, no longer requiring a new staff member to be hired or a new truck to be purchased.

In order to install a new dumpster, the land in the chosen area will need to be leveled and a concrete base will have to be poured for the dumpster to sit on. The cost for this can range from $10,000 to $15,000 depending on the location (Pellerin, 2007). Waste Management's cost to rent a dumpster is $190 per month. To haul the container is $114 per haul, and the cost per ton is dependent on what is placed in the compactor, ranging range from $30 to $90 per ton (Pellerin, 2007). Auburm MFR/FCR Inc charges a flat fee of $165 to haul plus $45 per ton. Trash and Recycling charges a flat fee of $127 to haul plus $37 per ton and will discount their price more if they handle other wastes WPI produces.

The advantage to commingled separate stream collection is that it generates more revenue compared to commingled single stream collection and requires very little additional effort on part of the custodial staff. The disadvantage is that new containers a new dumpster(s) will have to be purchased. The cost to purchase three dumpsters located at each of the dining facilities is cheaper than having one dumpster designated for all of

the University's recyclables. Fred DiMauro estimates that the cost to lease to purchase three dumpsters over three years, purchase new bins, and pay for hauling is $25,000 to $28,000. This is almost half as much as it would cost to hire a new custodian and operate a new truck at a total of $53,000, not including the purchase of one new dumpster. Additionally, once the recyclables leave the University, the bottles and cans will still have to be sorted into plastic, glass, and aluminum by a third party before being processed for reuse. This necessary additional labor by a third party means that the school does not make as much revenue compared to if the bottles and cans were already sorted.

4.2.3 Sorted Stream

Sorted stream collection separates office mix from bottles and cans, and further sorts bottles and cans into plastic, glass, and aluminum. In the event sorted stream collection is used, new collection bins for bottles and cans would be purchased.

Bins for commingled bottle and can collection should be purchased. At this point in time it is impractical for WPI to sort bottles and cans into plastic, glass, and aluminum upon first collection. This would require 3 bins, one for paper, one for plastic, and one for glass, to be placed in each target location, costing the school more money and taking up too much space. Bins for commingled can collection should be placed in target areas that have a constant flow of recyclables. Lounges on campus, especially those with vending machines, each floor of every dormitory, and the campus center should have designated bins for bottle and can collection. Additionally, each of these locations should receive office mix collection bins if they do not already have them.

The apartments should receive medium sized collection bins for bottles and cans with a smaller desk-side bin placed inside the medium bin to accommodate office mix collection. Two large collection bins, one for office mix and one for bottles and cans,

should be placed in the basement of Daniels near the entrance closest to the trash compactor to accommodate drop-off of the apartments' recyclables. New desk-side collection bins should be purchased for can and bottle collection and placed in faculty and staff offices next to the existing desk-side office mix bins. Much like what is currently done with the school's desk-side office mix containers, the new bottle and can desk-side bins should be emptied daily into larger bins by the custodial staff. Alternatively, the existing desk-side office mix bins could be used to collect bottles and cans in addition to office mix, and the custodial staff could manually separate the office mix from the bottles and cans upon collection; However, this is less desirable to custodial staff, would likely require greater compensation, and increase the chance of office mix contamination from leftover food and drink.

Similar to the University's current practices, when the large bottle and can bins are full they would be placed on the curb directly outside of the building they were collected in. The custodians would then load the bins into a WPI facilities truck and bring them to an intermediate sorting location. In the event the dumpster is located behind the tennis courts, sorting should take place in the storage building near the courts. Alternatively, sorting could take place in the basement of Daniels where there already exists a room where cardboard is temporarily stored. If the dumpster is located in the Campus Center parking lot, the large room inside the Campus Center located near the loading dock could be used for sorting. A compartmentalized dumpster must be purchased to accommodate sorted bottles and cans. The new dumpster should be located as close to the sorting location as possible to avoid additional transportation.

In order to install a new dumpster, the land in the chosen area will need to be leveled and a concrete base will have to be poured for the dumpster to sit on. The cost for this can range from $10,000 to $15,000 depending on the location (Pellerin, 2007). Waste Management's cost to rent a dumpster is $190 per month. To haul the container is $114 per haul, and the cost per ton is dependent on what is placed in the compactor, ranging range from $30 to $90 per ton (Pellerin, 2007). Auburm MFR/FCR Inc charges a flat fee of $165 to haul plus $45 per ton. Trash and Recycling charges a flat fee of $127 to haul plus $37 per ton and will discount their price more if they handle other wastes WPI produces.

The advantage to sorted stream collection is that it generates the most revenue compared to commingled single stream and commingled separate stream collection because the recyclable goods do not require additional sorting by a third party upon selling. There are many disadvantages to sorted stream collection. Additionaly, the increase in work caused by sorting will require a new custodial worker to be hired and a new truck to be purchased for transferring the recyclables the sorting location. According to Terry Pellerin, the cost to hire a third recycling custodian is $45,000 a year in salary plus $8,000 in operating costs for a new truck (Pellerin, 2007). The costs associated with accommodating sorted stream collection outweigh the revenue WPI stands to make on selling sorted recyclables.

4.3 Manpower

There are a variety of options available for supplying manpower to WPI's recycling program. Some methods utilize the framework of the school's existing recycling program while other methods explore new opportunities for collection.

4.3.1 Plant Services Staff

A system very similar to that which WPI uses to collect office mix recyclables, as described in Section 3.2, can be implemented for bottles and cans as well. Each evening, custodians would empty desk-side collection containers located in staff and faculty offices into lager, 50 gallon bins that are located in each building. When the 50 gallon bins are full, the custodians would place them out on the curb to be picked up by a WPI Facilities truck, which would then bring the materials to either a sorting location of a dumpster. The two WPI Facilities workers that currently handle recycling on campus would also process the cans and bottles. According to Terry Pellerin, if there is only one dumpster location, a third recycling custodian would be necessary to accommodate transferring Chartwells large load of recyclables. The bottle and can bins should be collected on a weekly basis, regardless of whether or not they are full, to prevent the build up of smell and bugs in the containers and to evenly distribute workers' time and effort.

4.3.2 First Year Program Students

The First Year Program has potential to obtain student manpower for a campus wide recycling program. Connie Peppes, Associate Director of the First Year Program, explains that the newly formatted First Year Program, implemented as of the 2007-2008 academic year, gives students the option to complete community service related to a

series of topic specific seminars called the Great Problems Seminars. Connie gives "Feeding the World" as an example of such a seminar in which students would learn about issues regarding world hunger. Other seminar topics currently include "Global Warming" and "Energy Supply and Use." After the seminar, students are presented with related community service opportunities. For example, the aforementioned "Feeding the World" seminar may offer opportunities at a local food bank or soup kitchen. Connie feels that WPI's recycling program could easily be incorporated into the seminars. Recycling plays an important role in both global warming and energy use and could be incorporated into these existing programs. Alternatively, a seminar on conservation and recycling tied in with volunteer opportunities within the campus recycling program could be developed. (Peppes, 2007)

Utilization of the First Year Program as a form of assistance to the recycling program has several benefits. First, it educates new students on campus about our program as well as the benefits of recycling. As students learn more about recycling, they increase their chances of developing positive recycling practices and becoming regular users of WPI's recycling program. Second, it has the potential to provide the program with manpower through volunteer opportunities given as part of the seminar. Finally, the Great Problems Seminars will provide a good tool for evaluating WPI's recycling program. Each seminar comes to completion with a final project. This project could be done on a yearly basis, evaluating the current program, its strengths, its weaknesses, and suggesting improvements that could be made, giving valuable feedback to the Department of Facilities.

An item of concern is whether or not the First Year Program would provide enough manpower to sustain a campus wide recycling program. At this point in time, the Great Problems Seminars would not be able to provide enough manpower, as the service opportunities presented during the seminars are not mandatory. However, in the future it is possible that students may be required to complete a certain amount of community service due to university policy or government requirements. Currently, only those students receiving financial aid through work study are required to complete a certain number of community service hours. This is further explained in Section 4.2.3. In such a case where community service is part of university requirements, there would be a steadier supply of workers (assuming students would select to work with the recycling program).

Another option within the First Year Program is the Insight Program in which students are grouped by living area and receive weekly advising and group activities. These groups often take on a specific topic and its related field of service. If one floor in each of the dormitories decided to focus on the recycling program, manpower would be evenly spread throughout the dormitories and each group would be responsible for bringing their building's recyclables to the curb. By coming together as a group rather than individually, the project gains more unity, a stronger driving force, and a greater sense of worth and responsibility in the service being done. Such positive characteristics would be ideal in propelling a campus wide recycling program from year to year. (Peppes, 2007)

While educating students about important issues and giving them the opportunity to be involved in their local community is a positive step, the actual number of students

who participate in the aforementioned community service opportunities would be a deciding factor for the recycling program's success. The ongoing development of the First Year Program leaves room for inclusion of the Campus Recycling Program. However, rather than have the program as a main source of workers, it would better serve as a supplement to the other collection methods described in this Chapter.

4.3.3 Federal Work Study Students

The Federal Work Study Program at WPI has the potential to be a steady source of student manpower for a campus recycling program if the program can be consistently maintained for several years.

In an interview with Erin Ahearn, Graduate Assistant of the Student Activities Office (SAO) and coordinator of the Community Service Work Study Program, she confirms that working the recycling program could be included as a job opportunity available through WPI's Community Service Center and Community Service Work Study Program. Unfortunately, after investigating current Federal Work Study requirements, the college campus is not considered a "community" in the definition of community service positions and therefore students hired to the recycling program would not qualify (U.S. Department of Education, 2007). While community service work study positions may be performed on campus, they must somehow relate or pertain to the improvement of the surrounding community WPI is located in (U.S. Department of Education, 2007).

Although 7 percent of all Work Study jobs must be performed in the field of community service, non-community service positions also qualify for Federal Work Study and have fewer restrictions. Federal Work Study Jobs may be in positions for the

school and its contactors, including and not limited to "food service, cleaning, maintenance, and security" (U.S. Department of Education, 2007). The Plant Facilities Staff would have to develop a position for student recyclers based on their need for manpower, and the school would designate the salary for these positions.

For the successful operation of a recycling program based solely on Work Study positions, all positions open to students by Plant Services would consistently have to be filled each year, ensuring that there was enough manpower to run the program. Frequently, not all of the Work Study positions available on campus are filled, leaving the possibility of an un-staffed program. Using the Work Study program as a supplement to a full time hired staff and possibly volunteers and first year students would be a much more practical option. If at some point the campus community's current environmental sentiments shifted from apathetic to highly concerned, students may be more open, willing, and interested in actively working recycling positions. In this case, a program staffed mainly by work study students may succeed.

4.3.4 Volunteer Basis

Depending on WPI's level of student activism, involvement, and interest in environmental affairs, a recycling program could be supported and staffed by volunteers. The degree to which volunteers play a role in the recycling program could range from minimal to extremely active. In the worst case possible, there would be no or few students, staff, and faculty interested in supporting the operations of the recycling program, making the program dependent on other options for manpower such as a hired staff. In the best case, the campus community would be extremely involved and active in the recycling program, aiding its operation and volunteering to perform collections and

educate the campus community. Unfortunately, WPI's current campus community is largely apathetic. While many people at the University are actively involved in and have strong opinions on environmental affairs, few appear to apply their interests in our campus community. This can be seen in the student body. For example, student life on campus includes an environmental club called GAEA. While the club has a surplus of members and runs several promotions each year to educate and help our school with sustainability, very few of these members are actively involved in the group's operations. Having witnessed a meeting of the organization, no more than 5 members showed up.

At this point in time, it seems impractical for a recycling program on campus to be primarily supported by volunteer efforts, mainly in part from our apathetic attitudes and reluctance to get involved. However, as the program develops and the campus becomes more educated on recycling thanks to informational programs, marketing strategies, and recycling propaganda, more students, faculty, and staff may become more willing to dedicate some of their time to assisting the program. While volunteer efforts may eventually grow to be helpful, it is important to realize that often volunteerism comes second to other commitments members of the WPI community have. For example, during midterms, finals, and breaks people will often prioritize their work as more important than volunteering with the recycling program, leaving a sudden lack of staff (Pellerin, 2007). On a college campus where this is unavoidable, volunteer efforts would most likely always have to be a supplement to a hired staff.

4.4 Removal of Recyclable Goods

Many companies around the Worcester area are available to haul WPI's bottles and cans and are presented in Table 4.1. These companies charge one flat fee to pick up recyclables and also an additional fee for each ton they process. WPI currently uses the Institute Recycling Network (IRN) for selling our existing recyclable goods, and the IRN would be able to sell WPI's bottles and cans as well. The IRN helps members find the best-suited contractor for the Institution. They will find WPI a company to sell our plastic and aluminum materials to, much like they do already with the other recyclable materials on campus. The advantage to this is that we already pay a $700 membership fee to be part of the IRN, utilizing our existing resources and avoiding extra costs. Additionally, the IRN is the only company available from which we will make profit, giving us back 85% of earnings and consequently making it the best option for removing our recyclables.

Table 4.1 Available Hauling Companies in the Worcester Area (as of 2007)

Company	Cost per Haul	Cost per Ton
Auburn MFR/FCR Inc	$165	$45
Worcester Trash and Recycling	$127	$37
Waste Management	$114	$40

4.5 Bins

Finding the best recycling containers to place throughout campus requires a balance between practicality and aesthetics. Some areas, such as the Campus Center, have aesthetics codes that require receptacles to meet certain guidelines. This may mean that containers must be a certain color or cannot have words printed on them. Such requirements cause a variety of setbacks. Blue and green colors are frequently associated

with recycling, while brown is often associated with trash. At WPI, brown containers are used for trash, paper, and cardboard deposit. In a case such as this, contamination can be a problem with people placing trash items into paper or cardboard bins. To help solve this setback, Terry Pellerin of Facility Services explains that he had the paper bins' lids locked shut and had a slit cut into them for accommodating paper deposit. Unfortunately, contamination still occurs and renders that entire bin of recyclables unusable.

A variety of solutions exist to prevent contamination and ensure accurate sorting. This includes clear labeling, color-coding, using clear receptacles, having appropriately sized lids based on intended collection, or a combination of the aforementioned. Ideally, a container should meet all of the previous criteria in order to ensure the most successful collection of goods. Clear labeling explicitly informs the user of which goods may be deposited into a container, however people do not always read labeling. Color-coding with the universal green and blue colors for recycling reduces trash being placed into bins if the colors are recognized and associated with recycling by the user. Unfortunately, sometimes these colors do not match the décor of the environment the bins are placed in. Clear receptacles allow the user to actually see what goods are being placed into the container and expose the user to the public making it less acceptable to be seen placing trash into a recycling receptacle. Unfortunately, clear containers put trash in plain sight, which can be aesthetically unappealing. Lids shaped strictly for bottle or paper deposit help prevent trash from being placed into containers while stressing a container's intended use. Another factor to consider when selecting bins are whether the lids expose containers' contents to the air, creating smells and if special liners must be bought for the containers.

Appendix D illustrates several styles of recycling containers available through several venders. Each container has its own strengths and weaknesses in terms of practical use and aesthetics.

4.6 Education and Publicity

Campus education and publicity are essential for running a successful recycling program. Proper education of the WPI community about the benefits of recycling and how the University's program is run will cause students, faculty, and staff to make value connections that compel them to recycle and ensure that bins will be properly used. Campus-wide publicity of the program will remind the community of the values they associate with recycling and help retain participants. Good education and publicity campaigns must be readily available and address the entire campus community. The Sustainable Endowments Institute gave WPI a grade of D- on the school's 2008 College Sustainability Report Card. The report card is graded based on the availability of information regarding sustainable practices, and shows that WPI does not publicize its information very well. The report card shows that without readily accessible information about the school's practices, such as the recycling program, the quality of the program suffers. Education and publicity are crucial.

Providing a short, educational presentation during New Student Orientation about WPI's recycling programs and the importance of recycling would introduce incoming students, typically freshmen, to the University's recycling program. The presentation could be delivered in a large forum by a staff member from the Department of Facilities or on a more intimate level in orientation groups by Orientation Leaders or Resident

Advisors. Providing educational information to incoming students is an integral aspect of the education campaign, as it introduces new members of the WPI community to the program with the intention of teaching them recycling skills which will last throughout their entire career at WPI.

During the first year the recycling program is implemented, an extensive campus-wide educational campaign should be run to educate all members about how to recycle at WPI, as they will not receive education through New Student Orientation. This will also provide education to the majority of faculty and staff who typically do not participate in New Student Orientation. This campus-wide educational campaign could be executed through an informational e-mail or through a one-time mailing on recycled paper. Afterward, on an annual basis an e-mail should be sent out to the entire WPI community that reminds students, faculty, and staff about the program.

As an important aspect of publicity, flyers should be posted on bulletin boards in academic buildings and dormitories to remind campus members about the program. The flyers should be printed on recycled paper to reaffirm WPI's commitment to sustainability. Additionally, programs such as Trash Art should continue to be run by GAEA in order to develop an interactive component to recycling education.

Finally, containers should be clearly labeled with which items can be deposited in them, much like some of the existing containers shown in Figure 3.3. This will ensure that the proper items are being placed in containers, helping with sorting and reducing contamination. Unlike Figure 3.3, labels should physically be placed onto the containers incase they move from their location.

5 Conclusions and Recommendations

5.1 Conclusions

The expansion of Worcester Polytechnic Institute's recycling program to include bottle and can collection is readily justified. An expanded program will not only meet the demands of WPI's immediate community articulated in Section 3.3, but will also bring the University up to the same standards so many other local and national universities, businesses, and communities have already committed to, as shown in Section 2.5 and Section 2.6. Most importantly, a comprehensive recycling program at WPI will reach towards a broader, global goal of sustainability.

There is increasing global pressure on the United States, especially from the European Union, to commit to sustainable practices which reduce the impacts of resource consumption, energy use, pollution, and global warming. As outlined in Section 2.1, recycling paper, plastic, aluminum, and glass works within sustainability's framework to reduce the negative impacts associated with virgin material acquisition and production. At this point in time, the European Union's commitment to sustainability is far more advanced than the United State's commitment, as shown through several European countries' extensive recycling programs in Section 2.2.

As a leading science and technology institution, WPI's growing commitment to sustainability in collaboration with other leading universities, businesses, and communities, will help prompt the development of a nationwide commitment to sustainability that is currently absent from our national and global policies. Nationwide change will only occur if organizations such as WPI can surmount the existing hurdles and prove that sustainability works in an everyday context.

5.2 Recommendations

Upon carefully considering the variety of options available for collecting bottles and cans on campus, we recommend the following to optimize the recycling program at WPI:

5.2.1 Bottle and Can Collection Method

Commingled separate stream collection, as explained in Section 4.2.2, is the cheapest and most effective method for collecting WPI's bottles and cans. New bins should be purchased for separate bottle and can collection and placed as described in Section 5.2.4. Three new dumpsters should be purchased and placed at each of the dining facilities: the Campus Center, Morgan Hall, and Founders Hall. By having three dumpsters at each dining location, the cost of hiring a new custodian and purchasing a truck is avoided because Chartwells workers will deposit their own recyclables into the dumpsters. The existing Facilities staff will handle the remaining recyclables on campus. Fred DiMauro estimates that the cost of leasing to purchase three new dumpsters over three years, hauling their contents, and buying new recycling bins is approximately $25,000 to $28,000.

Comparatively, the cost to use commingled single stream collection with the existing compacter, as outlined in Section 4.2.1, is $53,000 annually in order to hire a new staff member and operate a new truck; almost twice as much as using commingled separate stream collection. Even if the cost of a new staff member and truck is deferred by installing a compactor at each of the dining locations, the revenue the school makes in selling back commingled goods is less compared to bottles and cans that are separated from office mix, making commingled separate stream collection the better option.

Finally, sorted stream will require hiring a new staff member to assist in sorting, regardless if new dumpsters are purchased. This alone puts the cost of sorted stream collection at a starting rate of $53,000 annually, again making commingled separate stream the best option.

5.2.2 Manpower and Administrative Control

The recycling program at WPI should continue to be run by custodians working under the Department of Facilities. This is the most reliable source of manpower and the existing workers will require little to no additional training. In the future, if additional help is needed a Federal Work Study position should be developed by the Department of Facilities. A Federal Work Study student is preferred over hiring an additional custodian because comparatively Work Study positions cost less.

While not a necessary addition to the recycling program at this point in time, in the future it would benefit WPI to hire a Campus Sustainability Coordinator whose role is to oversee all sustainable operations on campus. The position would replace the existing President's Task Force on Sustainability, known as the Green Team. Currently the Green Team is made up of existing members of the WPI community who have other responsibilities on campus. By having a dedicated staff member to manage the school's sustainable operations, it would ensure that enough time is dedicated to planning and overseeing the campus's sustainable operations such as the recycling program.

5.2.3 Collection Company

We recommend the Institute Recycling Network continue to be used for selling WPI's bottles and cans, as the school already uses them for our cardboard and office mix, and they are the only company with which we stand to make a profit with. This contract

would minimize any cost and fees the campus would have working with any other outside company.

5.2.4 Collection Bins

Collection bins should be placed in locations where there is a steady presence of bottles and cans. This includes each floor of the dormitories, every apartment unit, all student lounges in academic buildings, next to vending machines, each floor of the Campus Center, within each Chartwells kitchen location (Morgan, Founders, Campus Center, and Catering Services), and in each faculty and staff office. Each location, except for the apartments and faculty and staff offices, should receive a 50 gallon bin to accommodate the high volume of traffic. The apartments should receive a medium sized bin and the faculty and staff offices should receive a desk-side bin to accommodate the smaller volume of people in these locations.

Bins should not be placed in the entranceways of all academic buildings, as the Green Team has suggested. The large flow of students through the entranceways during class changes makes bins in these locations primary targets for trash deposit. Students are passing through this area at a fast pace and will not take the time to determine what belongs in the bin. Trash will be deposited in these bins because it is most convenient, rendering any recyclables in the container contaminated and unusable. Additionally, locating recycling bins only in the entranceways of the academic buildings will reduce the amount of bottles and cans being recycled because it is inconvenient for people in the lounges and offices to walk to the entrance of the building to deposit their bottles and cans.

To maintain consistency with the existing paper and cardboard collection program at WPI, containers similar to those shown in Figures 3.1, 3.2, and 3.4 should be used. A

color coded system should be implemented for the containers, with brown equating with cardboard, blue with paper, and green with bottles and cans. The existing brown 50 gallon containers should continue to be used for cardboard collection and will save money by not having to replace these bins. At this point in time, not all 50 gallon paper collection bins are blue so blue 50 gallon containers designed for office mix collection should be purchased, as well as green 50 gallon containers for the new bottle and can collection aspect of the program. Rubbermaid carries a variety of 50 gallon containers and recycling specific container covers, as shown in Appendix D, which best match the University's existing containers.

5.2.5 Education and Publicity

While the Green Team's website is a good start to providing information about the recycling program to the WPI community, it does not ensure that the entire campus will be educated on the availability of and how to use the recycling system. For this reason, all educational and publicity techniques outlined in Section 4.6 should be executed. The two most essential components of Section 4.6 include informing new WPI members about recycling on campus and clearly labeling collection bins. It is not enough to simply have a recycling program in place. No matter how well designed the structure of the program is, the constant flow of incoming students, faculty, and staff pose a great risk because they are not educated about the recycling program upon arrival. New WPI members must be taught about the recycling program and constantly reminded about which items belong in each collection bin by labels in order to increase recycling participants, avoid contamination, and ultimately create a successful recycling program.

6 Works Cited

"About." ClimateChallenge.org. The Campus Climate Challenge. 11 December 2007 <http://climatechallenge.org/about>.

Ahearn, Erin. Personal Interview. 8 February 2007.

"Basic Information." *Climate Change*. 14 December 2006. U.S. Environmental Protection Agency. 11 February 2007 <http://www.epa.gov/climatechange/basicinfo.html>.

Birkby, Jeff. "Smart Communities Network: Creating Energy Smart Communities." Smart Communities Network. 2 October 2007 <http://www.smartcommunities.ncat.org/buildings/gbcodtoc.shtml>

Berkey, Dennis D. Personal Interview. 10 Dec. 2007.

"Chapter V – Basel Convention." *International Waste* Activities. 10 August 2006. U.S. Environmental Protection Agency. 22 February 2007. < http://www.epa.gov/epaoswer/osw/internat/basel3.htm>.

"Consequences of Global Warming." *Global Warming.* 9 January 2006. Natural Resources Defense Council. 11 February 2007 <http://www.nrdc.org/globalWarming/fcons.asp>.

Corvello, Paul. "City of Worcester, Massachusetts: Office of the City Clerk." 20 August 2000 Fe. Worcester City Council. 27 September 2007. <http://www4.ci.worcester.ma.us/weblink7/DocView.aspx?id=291347&searchhandle=19897>

Corvello, Paul. "City of Worcester, Massachusetts: Office of the City Clerk." 22 August 2004. Worcester City Council. 27 September 2007. <http://www4.ci.worcester.ma.us/weblink7/DocView.aspx?id=13021&searchhandle=28433>

Corvello, Paul. “City of Worcester, Massachusetts: Office of the City Clerk.” 30 Jaunuary 2007. Worcester City Council. 27 September 2007 <http://www4.ci.worcester.ma.us/weblink7/DocView.aspx?id=297105&searchhandle=28433>

“CU Recycling.” 2005. University of Colorado Environmental Center. 17 September 2007. <http://recycling.colorado.edu/index.html>

DiMauro, Alfredo. Personal interview. 3 Jan. 2008.

Foulkes, Imogen. “Recyling Around the World”. 25 June 2006: BBC News. 27 Sept. 2007. <http://news.bbc.co.uk/2/hi/europe/4620041.stm>

“Frequently Asked Questions.” *Recycling Program*. 2007. Clark University. 19 September 2007. <http://www.clarku.edu/offices/environment/faq.cfm>

“Global Warming Basics.” *Global Warming*. 9 February 2007. Natural Resources Defense Council. 11 February 2007 <http://www.nrdc.org/globalWarming/f101.asp>.

Flynn, Laurie J. “NY Times: Poor Nations Are Littered With Old PC’s, Report Says.” 24 October 2005. The New York Times. 23 February 2007. <http://www.refuseandresist.org/general/art.php?aid=2201>

GAEA. Meeting. October 2007.

Graham, Chis. “Friends of the Earth” 18 January 2005. Friends of Earth. 27 Sept. 2007 <http://www.foe.co.uk/resource/press_releases/new_recycling_figures_publ_1801 2005.html>

“Greenhouse Gas Emissions.” *Climate Change*. 7 February 2007. U.S. Environmental Protection Agency. 11 February 2007 <http://www.epa.gov/climatechange/emissions/index.html#ggo>.

Greer, Jed and Kenny Bruno. *Greenwash: The reality behind corporate environmentalism*. Malaysia: Third World Network, 1996.

Hassett, Heather. Email interview. 12 Dec. 2007.

"Health." *Climate Change*. 19 October 2006. U.S. Envionmental Protection Agency. 11 February 2007. <http://www.epa.gov/climatechange/effects/health.html>.

"History." *Recycling Program*. 2007. Clark University. 19 September 2007. <http://www.clarku.edu/offices/environment/history.cfm>

"Introduction." Secretariat of the Basil Convention. 21 February 2007. <http://www.basel.int/pub/basics.html>

"Kettle Creek Designs." 2007. Kettle Creek Designs. 30 September 2007. <http://www.kettlecreek.com>

"NEACURH Regional Conference." New England Affiliate of College and University esidence Halls. 2007. NEACURH, Inc. 11 Dec. 2007 <http://www.nacurh.org/NEACURH/ conferences/regional.php>

O'Brien, Michael. "City of Worcester, Massachusetts: Office of the City Clerk." 2007.Worcester City Manager. 30 September 2007. <http://www.ci.worcester.ma.us/dpw/home.html>

Pelillo, Noelle. "I.R.N.: Institute Recycling Network." 2007. The Institute Recycling Network. 2 October 2007 <http://www.ir-network.com/>

Pellerin, Terry. Personal Interview. 14 September 2007.

Peppes, Connie. Personal Interview. 2007.

"Physical Plant Recycles." *Recycling Program*. 2007. Clark University. 19 September 2007. <http://www.clarku.edu/offices/environment/pplant.cfm>

Pichtel, John. Waste Management Practices: Municipal, Hazardous, and Industrial. Boca Raton: CRC Press, 2005.

Powelson, David R. and Melinda A. Powelson. *The Recycler's Manual for Business, Government, and the Environmental Community*. New York: Van Nostrand Reinhold, 1992.

"Recycling at Clark." *Recycling Program*. 2007. Clark University. 19 September 2007. <http://www.clarku.edu/offices/environment/index.cfm>

"Recycling Center." *Recycling Program*. 2007. Clark University. 19 September 2007. <http://www.clarku.edu/offices/environment/center.cfm>

"Recycling Program." *Custodial Services and Events Support.* 15 August 2007. WPI Facilities Services. 17 September 2007. <http://www.wpi.edu/Admin/Plant/Building/>

Richardson, Janet Begin. Personal Interview. 11 Dec. 2007.

"Take Recycling to the Max." ClearStream by Resourceful. 2005-2006. Resourceful Bag & Tag, Inc. 27 September 2007. <http://www.clearstreamrecycler.com/home.asp>

"The Ultimate Recycling Equipment." RecyclingBin.com. 2007. Recycling Bins, Intercycle LLC. 30 September 2007. <http://www.recyclingbin.com>

Trabucco, Sally. Email interview. 11 Dec. 2007.

"University of Oregon Campus Recycling Program". 2006. University of Oregon. 6 October 2007. <http://www.uoregon.edu/~recycle/>

U.S. Department of Education. "Operating a Federal Work-Study Program." *2007-2008 FSA Handbook*. Vol. 6. 2007

Wallstrom, Margot. “Europa, Activities of the European Union: Summaries of Legislation”. 14 December 2004. European Union. 27 Sept. 2007 <http://europa.eu/scadplus/leg/en/s15002.htm>

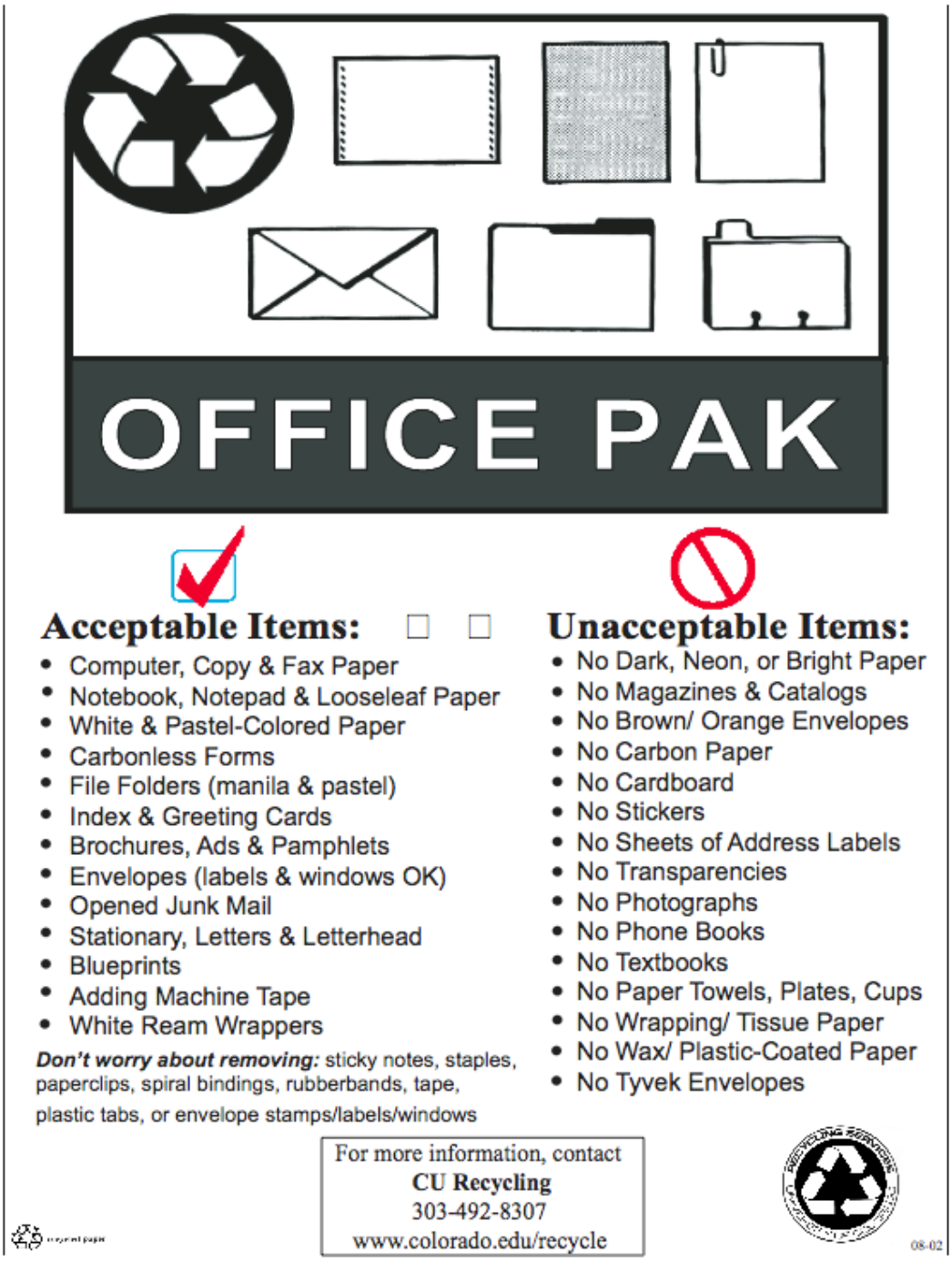
“Waste.” *General Catalogue*. 2007. Rubbermaid Commercial Products. 27 September 2007. <http://www.rcpworksmarter.com>

“What is the Basel Ban?” 2007. Basel Action Network. 22 February 2007. <http://ban.org/about_basel_ban/what_is_basel_ban.html>.

Wilder, Robert. E-mail interview. 18 Dec. 2007.

WPI Department of Facilities.15 August 2007. Worcester Polytechnic Institute. 2 October 2007 <http://www.wpi.edu/Admin/Plant/Building/>

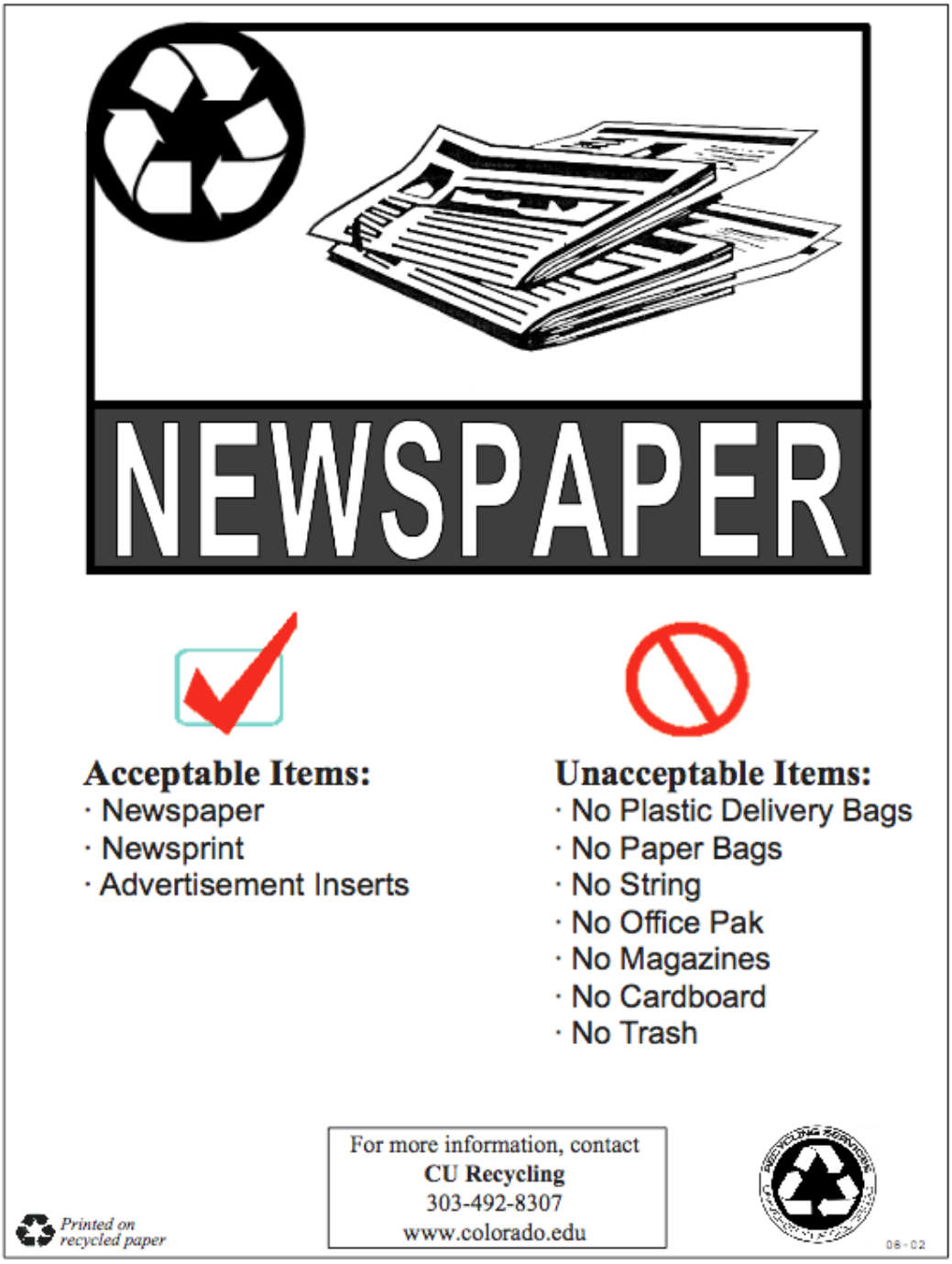
Appendix A. University of Colorado Recycling Flyers



(CU Recycling, 2005)

(CU Recycling, 2005)

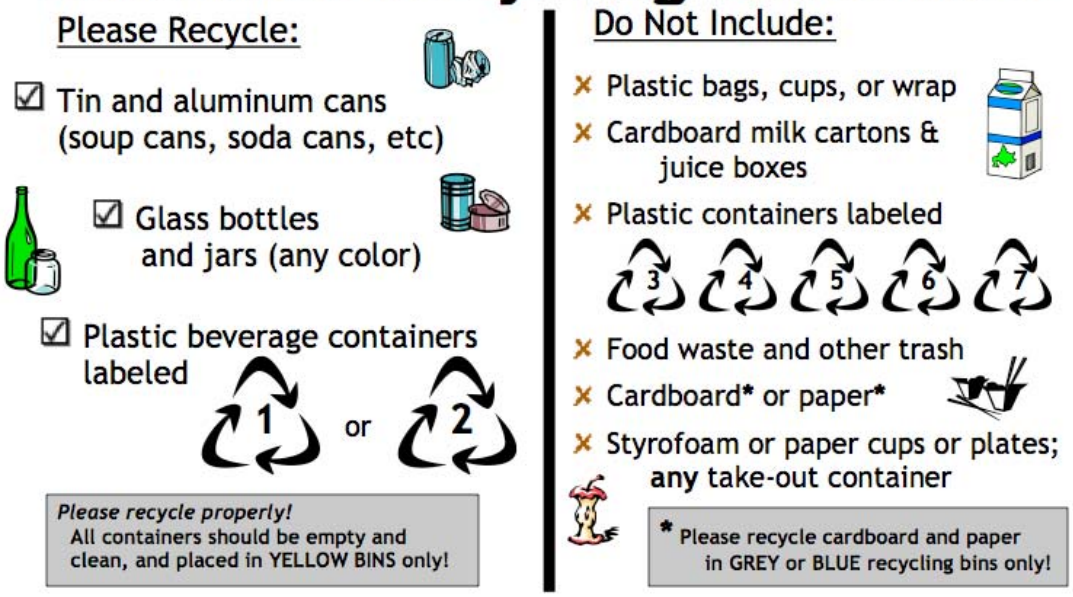
(CU Recycling, 2005)



(CU Recycling, 2005)

Appendix B. Clark University Recycling Guidelines

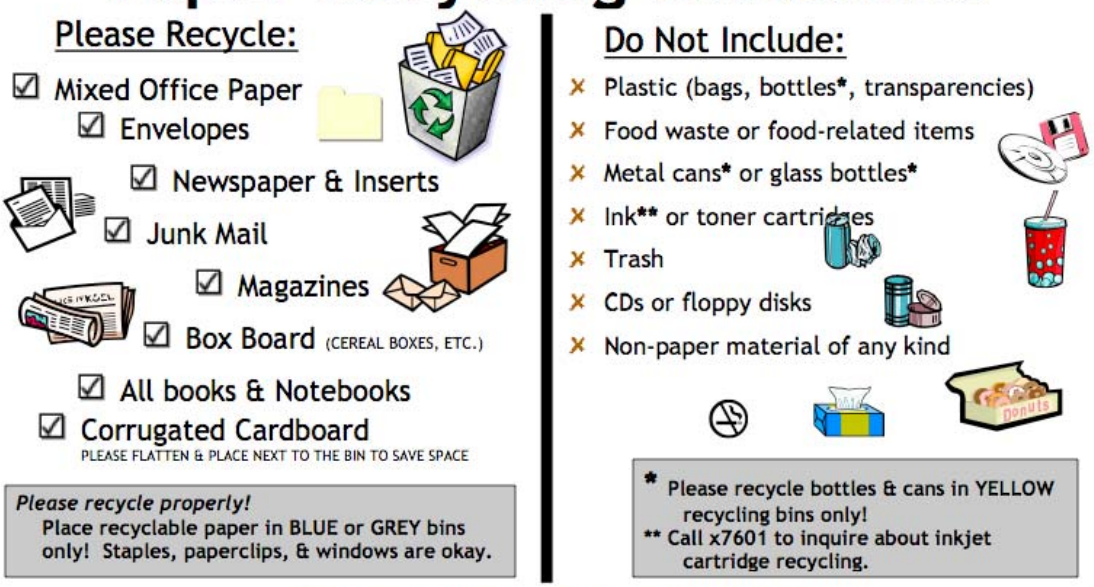
Clark University
Container Recycling Guidelines



Have a question that these guidelines don't answer?
Visit our website at www.clarku.edu/offices/environment or call us!
793.7202 (Recycling Center) or 793.7601 (Campus Sustainability Coordinator)

(Recycling at Clark, 2007)

Clark University
Paper Recycling Guidelines



Have a question that these guidelines don't answer?
Visit our website at www.clarku.edu/offices/environment or call us!
793.7202 (Recycling Center) or 793.7601 (Campus Sustainability Coordinator)

(Recycling at Clark, 2007)

Appendix C. GAEA Petition, 2003-2006

The WPI community believes it is important for their school to recycle aluminum cans, plastic bottles and other items. The following signatures are members of the community that want WPI to make it a priority to implement a recycling program where people can recycle at convenient locations.

Thank you.

	NAME	SIGNATURE	YOG
1.	Judith Duffy		2007
2.	Sam Gurwitz		2007
3.	Elizabeth Salazar		2004
4.	FAMECAGTASSON		2005
5.	Charles Kanob		2007
6.	Laura Mendes		2006
7.	Jamie Towle		2006
8.	Aaron Sikora		2004
9.	Megan Holmes		2005
10.	Ashley Hasdle		2006
11.	Megan Williamson		2006
12.	Emily Dodd		2003
13.	Valerie Ambrosie		2004
14.	Chris Baker		2006
15.	Amy J. Castonguay		2006
16.	Natasha Bogdanova		2005
17.	Jennifer Persico		2003
18.	Jasmin Zambrano		2006
19.	Cherie Fontaine		2003
20.	Dan Charbonneau		2003
21.	monica Giddings		2006
22.	Doug White		1987
23.	Jacob Vadalalala		2006
24.	Mark Marcello		2006
25.	Kris Carlson		2005

	NAME	SIGNATURE	YOG
1.	Kate Bernier	Kate Bernier	2006
2.	Jessica Jajosky	Jessica Jajosky	2005
3.	Nikhil Sreenath	Nikhil Sreenath	2006
4.	Ian Masias	Ian Masias	2006
5.	Helen Craig Williams	Helen Craig Williams	2005
6.	John Berube	John Berube	2003
7.	P. Jayachandran	P. JAYACHANDRAN	2003
8.	Chris DaCunha	Chris DaCunha	staff/BOT
9.	A.D. Iorio	A.D. Iorio	staff
10.	Charles Wilcox	Charles Wilcox	2003
11.	Daisy Susaya	Daisy Susaya	2006
12.	Tina Ruth	Tina Ruth	
13.	PAUL TYLER	Paul Tyler	2003
14.	Jonathan MacDougall	Jonathan MacDougall	2004
15.	Paul Armano	Paul Armano	2004
16.	Lisa Sasor	Lisa Sasor	2/14/03 4/04
17.	Matt Cheung	Matt Cheung	2005
18.	Dan Darling	Dan Darling	2005
19.	Sara Face	Sara Face	2006
20.	Drew Copeland-Will	Drew Copeland-Will	2006
21.	Eileen Kasacik	Eileen Kasacik	2007
22.	Megan Bickford	Megan Bickford	2005
23.	Molly Nawrath	Molly Nawrath	2005
24.	Rocky Lore	Rocky Lore	2006
25.	Martin Driggs	Martin Driggs	2006
26.	Nina Mallozzi	Nina Mallozzi	2005
27.	Nebiat Kidane	Nebiat Kidane	2006
28.	Jason Ma-Innes	Jason Ma-Innes	2005
29.	Jonathan Hurst	Jonathan Hurst	2005
30.	Chris Cabes	Chris Cabes	2006

The WPI community believes it is important for their school to recycle aluminum cans, plastic bottles and other items. The following signatures are members of the community that want WPI to make it a priority to implement a recycling program where people can recycle at convenient locations.

Thank you.

	NAME	SIGNATURE	YOG
1.	Paul Armano		2004
2.	Tim Mobley		2004
3.	Ed O'Connell		2005
4.	Carol Rivera Basnaji		2006
5.	Sean Coughlin		2004
6.	Matt Melia		2005 ... maybe
7.	David Norcott		2005
8.	Adam Trimby		2005
9.	Anthony Cosenza		2004
10.	Shawn McAvey		5/55
11.	Stephanie Marin		2004
12.	Alison Scoble		2004
13.	Brian Landry		2004
14.	Lauren Stolzar		2005
15.	Jessica Church		2004
16.	Paul Reitchel		200
17.	Bill McHugh		2004
18.	JAKE CONKLIN		2004
19.	Anne St. Martin		2006
20.	Sean Doherty		2005
21.	Jessica Reidel		2004/2005
22.	Amitra Setchell		2004
23.	Charles Wilcox		2004
24.	Michael Scheyde		2005
25.	Patrick Quinn		2005

	NAME	SIGNATURE	YOG
1.	Ryan Starbuck	Ryan	2007
2.	Michelle Porter		2004
3.	Jesse Elbin		2004
4.	Christopher Bea		2004
5.	Kotaro Kobayashi		2004
6.	Florentin Groeli		2004
7.	Tyler Amy		2004
8.	Daniel Barth		2007
9.	Jenna Ballestrini		2007
10.	[illegible]	Joseph Bush	2004
11.	Matt Cheung		2005
12.	DARIUS KAZEMI		2005
13.	David Bennett		2005
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The WPI community believes it is important for their school to recycle aluminum cans, plastic bottles and other items. The following signatures are members of the community that want WPI to make it a priority to implement a recycling program where people can recycle at convenient locations.

Thank you.

	NAME	SIGNATURE	YOG
1.	Drew Wilson	Drew Wilson	2007
2.	Allegra Moiser	Allegra Moiser	2007
3.	Stuart Floyd	Stuart Floyd	2007
4.	Heng Lian Huang	Heng Lian Huang	2007.
5.	Ryan Lizewski		2007
6.	Jillian Wise	Jillian Wise	2007
7.	Luke Adams	Luke Adams	2007
8.	Jacob Given	Jacob Given	2005
9.	Steven Willis	Steven Willis	2004
10.	Amanda Learned	Amanda Learned	2006
11.	Todor Kiryazov	Todor Kiryazov	2007
12.	Christian Banker	Christian Banker	
13.	Erica Abrahamsen	Erica Abrahamsen	2005
14.	Ryan Caron	Ryan P. Caron	2007
15.	Kyle Lewis	klewis@wpi.edu	2006
16.	Kate Youmans	Kate Youmans	2004
17.	Jeff Conkowycz	Jeff Conkowycz	2007
18.	Chris Puma	Chris Puma	2003
19.	Cody Rank	Cody Rank	2007
20.	RYAN FELTZ	Ryan Feltz	2007
21.	Moriah Knock	Moriah Knock	2006
22.	Peter Kay	Peter Kay	2006
23.	Rick Richter	Rick Richter	05
24.	Dave Toth	Dave Toth	Grad Student
25.	Michael Hy	Michael Hy	04

The WPI community believes it is important for their school to recycle aluminum cans, plastic bottles and other items. The following signatures are members of the community that want WPI to make it a priority to implement a recycling program in which people can recycle at convenient locations.

Thank you.

	Name	*Signature*	*Year of Grad.*
1.	Kevin Barrett	Kevin Barrett	2007
2.	Janelle Tavares	Janelle Tavares	2008
3.	Dima Rybak	Dima Rybak	2008
4.	Erin Ringer	Erin Ringer	2006
5.	Angela Chandler	Angela Chandler	2008
6.	Millisent Fung Hopkins	Millisent Fung Hopkins	2008
7.	Trisha Josephs	Trisha Josephs	2007
8.	Gissel Morales	Gissel Morales	2006
9.	Tahiyyah Mohammad	Tahiyyah Mohammad	2008
10.	Amal Hussein	Amal Hussein	2007
11.	Gregory Marcelin	Gregory Marcelin	2009
12.	Donna Davidson	Donna Davidson	2007
13.	Ergys Subashi	Ergys Subashi	2008
14.	Patricia Adamson	Patricia Adamson	2008
15.	Kyle Forward	Kyle Forward	2008
16.	Kevin Martinez	Kevin Martinez	2009

17.	Caitlin Sleziycki	Caitlin Sleziycki	2007
18.	Ravi Vasudevan		2008
19.	Vicky Urnea		2008
20.	Tom Nilfer		2007
21.	Dan Wartt	Dan	2007
22.	Christian Banker		
23.	Tri Quang Dang		2008
24.	Alexi Girgis	Alexi Girgis	2005
25.	Rachel Robillard	Rachel Robillard	2007
26.	Cheryl Kocsis	Cheryl Kocsis	2007
27.	Tate Carlson	Kristin Carlson	05
28.	Alec Tolivaisa		2008
29.	Andrew Anderson	Andy And	2008
30.	Erin McLean	Erin McLean	2008
31.	Akanksha Sharma	Akanksha	2008
32.	Matt Caulkins	Matt Caulkins	2008
33.	Henry Hovsepimian	Henry Hovsepimian	2008
34.	Emily Briskey	Emily Briskey	2009
35.	Kevin Clements	Kevin Clements	
36.	CALI O'CONNOR	Cali O'Connor	2009
37.	Peter Chamberlain	MA	
38.	Giri Girija Ramaprija	Giriji Ramaprija	2008

	Name	Signature	Year of Grad
39.	Stephanie Kavrakis		'09
40.	Brandon Patchel		'09
41.	Jason Hutchins		2009
42.	MARK RIZZO		2009
43.	Annie Vikant		2009
44.	Krystal Parker		2008
45.	Liz Kinnal		2008
46.	Daniel Bryant		2006
47.	Siobhan Fleming		2008
48.	Matt Boudreau		2009
49.	Robert Evers		2009
50.	Kelsey Graham		2009
51.	Eva Zipkin		2009
52.	Lester Li		2009
53.	Chuck Norris		2004
54.	J.J. Redick		2006
55.	Margaret Elbag		2009
56.	Robert Bernard		2009
57.	Daniel Christianson		2009
58.	Patrick Quinn		2007
59.	Deepu Raj		2009
60.	Chad Farrell		2009

61.	Jeffry Olson	Jeffrey Olson	2009
62.	Alexandra Sanseverino	Alexandra Sanseverino	2009
63.	Phyllis Wall	Phyllis Wall	2009
64.	Cara Macy	Cara Macy	2009
65.	CURTIS SCHAAF	Curtis Schaaf	2009
66.	Helena Alfonzo	Helena Alfonzo	2009
67.	Kyle Koppmeyer		2009
68.	Erik Davis	Erik Davis	2008
69.	Dan Szewczyk	Daniel Szewczyk	2009
70.	Katnryn Bomba	Kathryn S. Bomba	2009
71.	~~Christina Grant~~	~~Christina E Grant~~	~~2009~~
72.	Amanda Kent	Amanda Kent	2009
73.	Stephanie Colby	Stephanie Colby	2008
74.	~~Tess~~ de Tess de Rham	Tess de Rham	2008
75.	Nicholas Bartal	Nicholas Bartal	2009
76.	John Norton	John Norton	2008
77.	Ashley Gonzalo	Ashley A Gonzalo	2009
78.	Jennifer Hinotte	Jennifer A Hinotte	2009
79.	Eric Connelly	Eric Connelly	2009
80.	Kyle Feeley	Kyle Feeley	2009
81.	Shannon Casey		2009
82.	Eugene Choi		2009

83.	LAURA BELEN	Laura Belen	2009
84.	Rebecca Alay	Rebecca Alay	2009
85.	Alexandra Kulinkina	Alexandra Kulinkina	2009
86.	Derek Silsby	Derek J Silsby	2008
87.	Michael Spremulli	Michael Spremulli	2009
88.	Galya Traub	galya traub	2009
89.	Rebecca Baron	Rebecca Baron	2009
90.	Stephanie L. Carlyle	Stephanie L Carlyle	2009
91.	Eileen M. Gribouski	Eileen M. Gribouski	2009
92.	Amanda Gurnon	Amanda Gurnon	2009
93.	Nick Vitello	Nicholas Vitello	2009
94.	Derek Hall	Derek Hall	2009
95.	Keith Murphy	Keith Murphy	2009
96.	Gross Nazzo Jones		2004
97.	Kai Rasmussen		2005
98.	Jason Wasowski	Jason Wasowski	2005
99.	Rick Barbour		2006
100.	Greg Eschwey	Greg Eschwey	2006
101.	Mike Kissinger	Mark K. Kissinger	2006
102.		Jamie Levenseler	2008
103.	Mike Bertini	Mike Bertini	2006
104.	Elizabeth Arsenault	Elizabeth Arsenault	2006

105.	Craig Vanis		2006
106.	Giacinna Pawsley		2008
107.	Srinivasan		staff
108.	William Petrone		2008
109.	Jordan Gomes		2006
110.	Merrill B. Lamont III		2007
111.	Marcella Corcoran		2006
112.	Whitney Moore		2006
113.	Matthew Lee		2006
114.	Linsley Kelly		2007
115.	Chloé Wiseman		2008
116.	Morgan Carpenter		2008
117.	Katarzyna Kosacielska		2008
118.	Amrita chakrabarti		as.
119.	Sam Feller		2007
120.	Marty Driggs		2006
121.	Laura Baldassari		2006
122.	Pranela Nayak		2009
123.	Kate Benner		2006
124.	Stephen O'Dey		2006
125.	Jaron Kuppers		2006
126.	Beth	Beth Covey	2008

127.	Anita Minakyan	Anita Minakyan	2008
128.	Heather Burkart	Heather Burkart	2006
129.	Sofie Kniazeva	Sofie Kniazeva	2008
130.	Becky Legare	Rebecca Legare	2007
131.	Victoria Richardson	Victoria Richardson	2008
132.	Michelle Ladouceur	Michelle A. Ladouceur	2008
133.	Sarah Van Oosbeeren		2008
134.	Ashley Maiorano	Ashley Maiorano	2007
135.	Elise Clay	Elise Clay	2006
136.	Nicole Labbe		2006
137.	ANDREA FLYNN	Andrea Flynn	2006
138.	Cosme Furlong	C. Furlong	
139.	Ryan Kendrick		2008
140.	Alex White		2006
141.	Keith Flanders	Keith Flanders	2009
142.	Bonnie Jean Boettcher	Bonnie Jean Boettcher	2002
143.	Jeremy Shaw		2007
144.	Nicholas LoBue		2007
145.	Paula A. Restrepo	Paula Rpo	2006
146.	Alex Isbister	Alex Isbister	2009
147.	Kerri Morgello	Kerri Morgello	2006
148.	Kristopher Houle	Kristopher M Houle	2006

149.	David Pesce	David P Pesce	2007
150.	Tatiana Winey		2007
151.	Geoffrey Batstone	Geoffrey Batstone	2007
152.	VIRGINIA O'CONNELL	Virginia O'Connell	2006
153.	Devin Oakes	Devin Oakes	2008
154.	MICHAEL CIARALDI	Michael Ciaraldi	CS-FACULTY
155.	Ethan Ray	Ethan Ray	2007
156.	Mike Hansen	Mike Hansen	2007
157.	LIZ PALUMBO	Elizabeth Palumbo	2006.
158.	Marsha D'souza	Marsha D'souza	2007
159.	Shauna Martinelli	Shauna Martinelli	2007
160.	MANNA NEGHASSI	Manna Neghassi	2006
161.	Jocelyn Lally	Jocelyn Lally	2005
162.	Emily LoPresti	Emily LoPresti	2006
163.	Brianne O'Neill	Brianne O'Neill	2007
164.	Phil Roy	Phil Roy	2006
165.	Tantra Budiman	Tantra Budiman	2008
166.	Andrew Lingenfelter	Andrew Lingenfelter	2008
167.	Sandro Pai	Sandro Pai	2008
168.	Kyle Feeley	Kyle Feeley	2009
169.	Jenelle Pope	Jenelle Pope	2007
170.	Derek Dowd	Derek Dowd	2007

171.	Shane Christy	Shane Christy	2009
172.	Michael Tiv	Michael A Tiv	2008
173.	Jennifer Moseley	Jennifer Moseley	2008
174.	David J. López	David J López	2008
175.	Peter Sawosik	Peter Sawosik	2008
176.	Parth Bhuptani		2007
177.	Deanna Wolfson		2006
178.	Jen Gilbert	Jen Gilbert	2008
179.	April Vaillancourt		2006
180.	Karl Wiegand		2008
181.	Julie Buffam	Julie Buffam	2008
182.	Hallie Schiess	Hallie Schiess	2008
183.	Kate Kolosowski-Bagen		2007
184.	Sanjayan Manivannan		2007
185.	Chelsea Bierkan		2008
186.	Sara Puran		2008
187.	David Susco	David Susco	2005
188.	Sarah R. Epstein	Sarah R Epstein	2006
189.	Andrea Havey	Andrea Havey	2008
190.	Jessica Byron	Jessica Byron	2008
191.	Brendan Wilson	Brendan Wilson	2006
192.	Andrea Portnoy	Andrea L. Portnoy	2008

193.	Jonathan Sullivan		2008
194.	Kyle Ozil		2008
195.	RYAN FOLTZ		2007
196.	Tim Clifford		2007
197.	Julia Cohn		2006
198.	Jessica Coelho		2008
199.	Liza Tuttle		2008
200.	Gabriella Serrati		2009
201.	Becci Ziemba		2006
202.	Tystan Obey		2006
203.	AMBER Neves		2004
204.	Augustina Mills		2009
205.	Nasa Braky		2006
206.	Jun Fu Chang		2007
207.	George Marten		2007
208.	Daniel Eggleston		2007
209.	MARTIN Meyer		2006
210.	Michael LaBossiere		2005
211.	Brandon Germain		200X
212.	Mark Stevenson		20X6
213.	Chris Woo		2008
214.	Adam Wilbur		2006

215	[signature]	Ben Mies	2007
216	[signature]	Owen Roberts	2007
217	[signature]	Jake Dorcet	2007
218	Nicholas LeBaron	[signature]	2008
219	Wasim Quddus	[signature]	2007
220	Stuart Haws	[signature]	Grad
221	Elias	[signature]	Grad
222	Laura Saltzman	[signature]	2009
223	Jessica Balesano	[signature]	2008
224	Ryan Trunko	[signature]	2008
225	[signature]	Jonathan Gibbons	2008
226	Thomas Dixon	[signature]	2008
227	[signature]	Lauren Gray	2006
228	[signature]	Mary Wood	2006
229	Mike Kristan	[signature]	2007
230	PAUL FERREIRA	[signature]	2007
231	[signature]		2007
232	Alex Cunningham	[signature]	2008
233	Ross Hudon	[signature]	2009
234	Julie Chapman	[signature]	— Staff
235	Jennifer Cluett	[signature]	— STAFF
236	Brian Foley	[signature]	2007
237	Mandi Provencher	[signature]	2007
238	Andrew Schwalbenberg	[signature]	2009

239	Nicholas Simoe	Nicholas Simoe	'08	
240	Brendon McNeil	Brendon McNeil	'06	
241	BRANKO ZUGIC		'06	
242	Ari Hart	Ari Hart	'06	
243	Rob Watt	Rob Watt	'04	
244	Jarrhy Montenegro		'07	
245	Aaron Bergeron	Aaron Bergeron	'06	
246	Megan Holmes	Megan Holmes	'08	
247	Belinda Barbagallo		'07	
248	Daniele DeOssie		'07	
249	M Blackwell-Tomkins		'06	
250	Mustang GT		05	
251	Lesley Blumberg	Lesley L Blumberg	'07	
252	Antonia Skaltsis		'09	
253	Rachelle Horwitz	Rachelle L Horwitz	08	
254	Carol Bussmann		06	
255	Maureen Ryder	Maureen E Ryder	09	
256	Allison DiNatale	Allison DiNatale	08	
257	Munaf S. Aamir		07, 08	
258	Kevin Harrington		08	
259	OZAN BASKAN		07	
260	Mustafa Konca		08	
261	Jonathon Shemaker	Jonathon D. Shemaker	09	
262	Elisabeth Smirnitski		06	

263	KATHLEEN Farrell	Kathleen Jergyson	06	1
264	Nathan Roy	Nathan Roy	09	
265	Erica Moore	Erica Moore		07
266	Amanda McCullagh	Amanda McCullagh		07
267	Mark Lindblad	Mark Lindblad		09
268	Katie Siering	Katie Siering		09
269	Robert Hafner	Robert Hafner		08
270	Mary Servatius	Mary Servatius		06
271	Nicholas McBride	Nicholas McBride		07
272	Paul Kastner	Paul Kastner		06
273	Olivia Mukerji	Olivia Mukerji		09
274	Adrian Farrell	Adrian Farrell		08
275	Justin Mattern	Justin Mattern		06
276	Jonathan Leslie	Jonathan Leslie		06
277	Nathaniel Piper	Nathaniel Piper		08 isa
278	Jón Grétarsson	Jón Grétarsson		06
279	Sara Gouveia	Sara Gouveia		08
280	Amy Castonguay	Amy Castonguay		08
281	Jim McGinley	Jim McGinley		06
282	Chatura Welivitigoda	Chatura Welivitigoda		06
283	RYAN CARON	Ryan P. Caron		07
284	NICOLE KEENAN	Nicole Keenan		06
285	Laurie Carpenter	Laurie Carpenter		06
286	Topher Schott	Topher Schott		06
287	Charles Gammal	Charles Gammal		08
288	Liz Villani	Liz Villani		08

	NAME	SIGNATURE	YOG
289	YARALIA CASTILLO	Yaralia Castillo	2007
290	Amanda Tabet	Amanda Tabet	2007
291	Kelly Martin	Kelly Martin	2007
292	Gary Contois	Gary Contois	2007
293	Chris Gilmore	Chris Gilmore	2006
294	Tom Bullens	Thomas Bullens	staff
295	Nicole DeCampo	Nicole DeCampo	2008
296	Lynn Worby	Lynn Worby	2008
297	Matt Schulze	Matt Schulze	2008
298	Penny Gikas	Penny Gikas	2008
299	Megan Yocom	Megan Yocom	2008
300	Kelly McNally	Kelly McNally	2007
301	Ashley Bargauld	Ashley Bargauld	2006
302	Erin Ellsworth	Erin M.	2006
303	Elizabeth Stewart	Elizabeth J. Stewart	2008
304	Cristiana Ciocoiu	Cristiana Ciocoiu	2008
305	Jara Praschak	Sara Praschak	2007
306	Genevieve Desaulniers	Genevieve Desaulniers	2008
307	Lee Sieradzki	Lee Sieradzki	2007
308	Jonathan Adler	Jonathan Adler	2008
309	JOSEPH STRAUSS	Joseph Strauss	2009
310	Justin Rockwell	Justin Rockwell	2006
311	Susan R Moore	Susan R Moore	2008
312	Michael McSweeny	Michael McSweeny	2009
313	Joanna Kluza	Joanna Kluza	2007
314	William Fay	William Fay	2007
315	Pamela Lewandowska	Pamela Lewandowska	2005
316	Helen A Hanson	Helen A Hanson	2006
317	Ian Anderson	Ian Anderson	2008
318	Alexander Christakis	Alexander Christakis	2010

	NAME	SIGNATURE	YOG
319	Allison Johnson	Allison Johnson	2006
320	Jack Schafer		2005
321	Maurice Williams		2009
322	Brian Cordes	Brian Cordes	2005
323	Jessica Tatem	Jessica Tatem	2006
324	Matt Krolak		200?
325	Candace O'Connor	Candace O'Connor	2007
326	Matthew Shaw	Matt J. Shaw	2006
327	Adam Brodas	Adam C. Brodas	2006
328	Diana Dawyanova		2008
329	Vincent Taormina		2006
330	Karyn Gottardi	Karyn Gottardi	2009
331	Shannon P. Leary		2009
332	David Cesavant		06
333	Michael Leonardo		2006
334	Lesley Anderson	Lesley Anderson	2006
335	Laura Barry	Laura Barry	2009
336	Chris Andrews		2008
337	Dominic DiGiovanni	Dominic DiGiovanni	2009
338	Sean Waithe	Sean R. Waithe	2008
339	Alice L. A. Nader		2009
340	Timothy Mulhern	Timothy J. Mulhern	2009
341	Timothy Mosig	Timothy Mosig	2006
342	Steve Zurkowski	Steve Zurkowski	2009
343	Cody Rank	Cody Rank	2007
344	Allison Vasallo	Allison Vasallo	2008
345	Nick Bibel	N I B	2008
346	Greg Opperman	Greg Opperman	2007
347	Chris Balkow	Chris Balkow	2007
348	Alex Forrest	Alexander Dibenedetto	2008

	NAME	SIGNATURE	YOG
349	Stacy Haponik	Stacy Haponik	2007
350	Tom Ward	Tom Ward	2009
351	John Potter	John Potter	2006
352	Alyssa Lopes	Alyssa Lopes	2006
353	Matt Donovan	Matt Donovan	2006
354	Maria Mavromatis	Maria Mavromatis	2006
355	Jennifer Keating	Jennifer Keating	2009
356	Justin Parker	Justin Parker	2007
357			
358			
359			
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375			
376			
377			
378			

NAME	SIGNATURE	YOG
Amanda Jean Novak	Amanda Jean Novak	2006

Appendix D. Available Recycling Containers

Rubbermaid Recycling Containers (Waste, 2007)

Unit Name	Colors	Notes	Dimensions	Volume	Price/Unit	Units/Pack
 Round Container Model 3546	Beige, Gray	Indoor Use	15 3/4" dia. X 30 1/8" h	22 gal	$14.80	4
 Funnel Top Model 3548	Gray	Fits Round Container Model 3546	16 1/8 dia.	n/a	$6.25	4
 Slim Jim Waste Container Model 3540-06	Blue	Indoor Use	23 1/8" l x 11" w x 30"h	23 gal	$15.05	4

 Slim Jim Bottle and Can Recycling Top Model 2692-88	Brown, Green	Fits Slim Jim Waste Container Model 3540	20 3/8” l x 11 5/16” w x 2 3/4" h	n/a	$9.70	4
 Slim Jim Paper Recycling Top Model 2703-88	Blue	Fits Slim Jim Waste Container Model 3540	20 3/8” l x 11 5/16” w x 2 3/4" h	n/a	$9.70	4
 Glutton Container Model 256B-06	Dark Blue	Outdoor Use	25 1/2" l x 22 3/4" w x 31 1/8” h	56 gal	$49.50	4
	Dark Blue	Outdoor Use	26 5/8” l x 23” w x 13” h	n/a	$233.00	1

Glutton Bottle & Can Recycling Top Model 256L						
 Plaza Container Bottle & Can Model 3968	Dark Blue	Outdoor Use	24 3/4" l x 25 1/4" w x 42 1/8” h	50 gal	$594.00	1
 Plaza Container Paper Recycling Model 3969	Dark Blue	Outdoor Use	24 3/4" l x 25 1/4" w x 42 1/8” h	50 gal	$594.00	1

 Square Recycling Container Model 3958-06	Dark Blue	Indoor Use	19 1/2" sq x 27 5/8” h	35 gal	$27.00	4
 Square Recycling Container Model 3959-06	Dark Blue	Indoor Use	19 1/2" sq x 34 1/4” h	50 gal	$37.50	4
 Untouchable Bottle & Can Recycling Top Model 2791	Dark Blue	Fits Square Recycling Container Model 3958-06 and Model 3859-06	20 1/8” sq x 6 1/4" h	n/a	$14.60	4

 Untouchable Paper Recycling Top Model 2794	Dark Blue	Fits Square Recycling Container Model 3958-06 and Model 3859-06	20 1/8” sq x 6 1/4" h	n/a	$14.60	4
 Small Deskside Recycling Container Model 2955-06	Blue	Deskside Use	11 3/8” l x 8 1/4" w x 12 1/8” h	13 5/8 qt	$0.82	12
 Medium Deskside Recycling Container Model 2956-06	Blue	Deskside Use	14 3/8” l x 10 1/4" w x 15” h	28 1/8 qt	$0.87	12

 Large Deskside Recycling Container Model 2957-06	Blue	Deskside Use	15 1/4" l x 11” w x 19 7/8” h	41 1/4 qt	$1.67	12
 Vanity Wastebasket Model 2952	Beige	Fits inside Medium Deskside Recycling Container	9 7/8” l x 6 3/4" w x 10 1/8” h	8 1/8 qt	$1.07	6

Intercycle LLC Recycling Containers (The Ultimate Recycling Equipment, 2007)

Unit Name	Colors	Notes	Dimensions	Volume	Price/Unit	Units/Pack

 MegaBin – Large Capacity Recycling Bin	Brown (for trash only), Green (recycling only), Blue (recycling only)	Indoor/Outdoor Use; Availabe for Trash or Can & Bottle Collection	22” d x 42” h	50 gal	$69	2
 HexCycle II	Blue, Green, Silver, Black	Indoor/Outdoor Use; Can & Bottle, Paper, or Large Opening Lids available	18” w x 40” h	29 gal	$38.95 (2 for 35.95/3+ for $33.95)	1

 Steel HexCycle II	Blue, Black	Indoor/Outdoor Use; Can & Bottle Collection	16” x 19” x 40” h	29 gal	1-5 $143 ea□6-10 $139 ea□11-19 $136 ea□20+ $129□Add $16 for Black/Silver□	1
 DeskMate – Under Desk Recycling Bins	Blue, Green, Black	Desk side Use; Available for Can & Bottle or Paper Collection	7.75” x 11.75” x 15”	3.4 gal	3-15 $14.33 ea□18-27 $13.66 ea□30+ $13.00 ea	3
 SteelCycle Steel Recycling Bins	Blue	Indoor/Outdoor Use; Available for Can & Bottle or Paper Collection	17” x 17” x 30”	30 gal	1-3 $175 ea□4-7 $172 ea□8+ $169 ea	1

 Complete Recycler – HexCycle II Low Profile	Green, Blue, Silver, Black	Indoor/Outdoor Use; Can & Bottle, Paper, or Large Opening Lids available	18” x 30” h	22 gal	$38.95 (2 for 35.95/3+ for $33.95)	1
 Available Lids					Included in Bin Purchases	

 Available Labels		Custom Labeling and Graphics Available			Included in Bin Purchases	

ClearStream Recycling Containers (Take Recycling to the Max, 2007)

Unit Name	Colors	Notes	Dimensions	Volume	Price/Unit	Units/Pack
 ClearStream CycleMax	Blue	Bottle & Can Deposit Lid	10” x 24” x 40.875”	Accommodates 55 gal barrel bags (must be at least 38” in dia)	1-11 packs: $50.00 ea 12-23 packs: $46.50 ea 24-47 packs:	5

					$44.00 ea 48+: call	
 ClearStream PaperMax	Green	Paper Deposit Lid	10” x 24” x 40.875”	Accommodates 55 gal barrel bags (must be at least 38” in dia)	1-11 packs: $50.00 ea 12-23 packs: $46.50 ea 24-47 packs: $44.00 ea 48+: call	5
 ClearStream MultiMax Custom Containers	Blue, Green, Black	Wide mouth Deposit Lid	10” x 24” x 40.875”	Accommodates 55 gal barrel bags (must be at least 38” in dia)	$56.00	5
Linear Low Density Clear Recycle Bags – Medium Duty	Clear with Blue		40” x 46”		$0.50	100 bags/case

	Print					

Kettle Creek Recycling Containers (Kettle Creek Designs, 2007)

Unit Name	Colors	Notes	Dimensions	Volume	Price/Unit	Units/Pack
 Cornice						
 Tuscarora						

 Confluence						