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Innovative recycling options for biomedical research facilities

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Almost everyone agrees that recycling is the right thing to do whenever feasible. Recycling prevents the emission of many greenhouse gases and water pollutants, saves energy, supplies valuable raw materials to industry, creates jobs, stimulates the development of greener technologies, conserves resources, and reduces the need for new landfills and combustors¹. The widespread adoption of Environmental Management Systems (EMS), ISO 14000, executive order 13148, and the growing environmental stewardship movement have all helped increase the popularity of beneficial reuse programs. Biomedical research facilities can offer unique recycling opportunities for the creative manager.

This is the story of a successful recycling program at the National Cancer Institute at Frederick (NCI-Frederick). The NCI-Frederick campus is located inside the gates of the Ft. Detrick U.S. Army Garrison (USAG) which is approximately 45 miles north of Washington, DC. The NCI-Frederick is home to over 300 research laboratories, has over 85 buildings, and employs approximately 3,000 people. NCI-Frederick is not ISO 14,000 certified. The campus has a large scale paper, cardboard, glass, aluminum, #1 (PETE) & #2 (HDPE) plastic, wood pallet, and metal recycling program. Investigation found that pipette tip boxes, a #5 (PP) plastic, made up a substantial portion of the total NCI-Frederick medical waste stream and was not recycled. The USAG did not have the logistical support needed to expand their operation to include #5 plastics. In 2003, the Environment, Health and Safety (EHS) division sought out new recycling options and started a pilot scale recycling program, which includes #5 plastics.

While companies willing to accept #5 plastic are relatively few compared to those that accept #1 or #2 plastics, there does exist a growing market for this material. After some research, EHS discovered a company that was making pickups of ground #5 plastics from the National Institutes of Health (NIH). NIH is located about 40 miles away in Bethesda, MD.

EHS requested that researchers segregate and bag empty pipette boxes into clear 30 gallon polyethylene bags. EHS waste management staff picked up the bags once a week from laboratories that requested a pickup (Figure 1). Every month the bags were transported to NIH. The NIH staff would grind the pipette boxes into palletized cubic yard boxes for shipment to the recycler (figure 2). The recycling company collected the granulated cubic yard boxes and sold them as raw material for polymer manufacturing. Recycled PP is typically used to manufacture signal lights, car battery components, brooms, brushes, oil funnels, ice scrapers, bike racks, pallets, and storage bins/trays².

There were some initial concerns about the potential of biologically contaminated pipette boxes. However, it was discovered that very few of the operations had an actual potential for contamination. When there was biological contamination, the boxes were either chemically disinfected by the researchers, autoclaved, or simply excluded from recycling. Although autoclaving causes slight melting and distortion, this was acceptable as the boxes were eventually granulated.

One of the main reasons the recycling program works at NCI-Frederick is because EHS was able to utilize existing space and staff. The waste management staff was already visiting most of the laboratories regularly to pick up chemical and radioactive waste, as well as to conduct laboratory inspections. Otherwise, the recycling effort would not pay for the trucks, warehouse space, and the additional staff needed to perform the labor needed for such a program. The staff was able to augment their normal pickup routine in order to include the recycling without much additional logistical support. In addition, the researchers at NCI-Frederick are supportive for most recycling initiatives resulting in a high level of participation from the generators of the material.

Collection volumes of pipette boxes at NCI-Frederick increased to the point where storage space was insufficient. Lack of storage space, along with rising fuel costs associated with the frequent trips to Bethesda, gave EHS enough justification to purchase a plastic grinder. EHS grinds the tip boxes onto palletized cubic yard boxes and has the hauler pick up the plastic from the NCI-Frederick facility, thus cutting out the deliveries to Bethesda. The grinder includes a powder capable vacuum transport system that dumps the grindings directly into a cubic yard box (Figure 3).

An audit of the effectiveness of the pipette tip box recycling program revealed several benefits. The recycler refunds three cents per pound for the value of the plastic, but the real benefit is in sending less medical waste to the incinerator. The USAG assesses a cost of two cents per pound for disposal of medical waste. This is a comparatively low price because of the convenience of having a government funded incinerator on campus. The NCI-Frederick also leases property outside of Ft. Detrick for research use, the Laboratory of Molecular Technology (LMT). The LMT is located a few miles outside of Ft. Detrick. LMT has a contract for medical waste independent of the USAG and is typical of research facilities not associated with a large army garrison. The current contractor charges this facility \$30.11 for an 18 gallon box for medical waste disposal. LMT also uses a gene sequencing robot that processes a large volume of tip boxes, which were previously disposed as medical waste. Each bag of boxes EHS recycled was about the size of a medical waste box, thereby saving \$30.11 of contract money per bag. In 2004, EHS recycled 82 bags of pipette boxes from LMT, thereby saving a total of \$2,460 of contract money not including the three cents per pound of refund by the recycler. From 2003 to 2006, EHS recycled approximately 8,400 pounds of pipette tip boxes from LMT saving approximately \$7,400 in medical waste contract money from this one off-site building. In comparison, the main campus on Ft. Detrick was able to divert close to 45,000 pounds from the medical waste stream (Table 1).

The real benefit in recycling includes reduction in greenhouse gas emissions and environmental impact. In general, recycling a ton of plastic saves about as much energy as is stored in 197 gallons of gasoline². Since 2003, EHS has recycled a total of approximately 52,189 pounds (26 tons), of plastic from the pipette recycling program. This is the equivalent of saving 5,122 gallons of gasoline and a total greenhouse gas reduction of 45 metric tons of Carbon Dioxide Equivalent³.

All refund money from the value of the recycled material is donated to The Children's Inn at NIH⁴. The Inn is a private, non-profit, family-centered residence for pediatric outpatients at the NIH and for their families. This donation increases the popularity of the program.

In 2004, EHS found another overlooked recyclable material in the medical waste stream: Tyvek garments. Tyvek garments are used by animal facility operations, clean rooms, and by facilities maintenance personnel. EHS located a company that would accept all Tyvek suits, boots, sleeves, and other garments and recycle them. They accept any size shipment, will refund the shipping cost, and give a credit of twenty-five cents per suit for intact garments. The company launders the garments and re-sells them to industries such as construction, tank cleaning, and painters that do not require brand-new garments. Similar to the pipette boxes, biologically contaminated suits are autoclaved and accepted by the recycler. The garments are also collected in clear polyethylene bags and picked up by request (Figure 4). Unlike the pipettes tip boxes, the cash return on Tyvek recycling was much larger. In 2005, 102 bags of Tyvek material was collected for a total of \$1,566 in direct refund, as well as diverting 1,723 pounds of material from the medical waste. If our small offsite facility had generated this amount it would have cost approximately \$3,000 to dispose of the suits as medical waste.

In 2005, printer cartridges were identified as another recyclable material often discarded. Companies were researched and a few were found that would not only accept used printer cartridges of all types, but also pay a credit for some brands and models. EHS began to collect LaserJet, inkjet, and toner cartridges from all administrative areas. Simple cardboard boxes were placed in central locations, such as copier rooms, for staff to place empty cartridges. EHS picked these up when full, and palletized them for shipment. The cartridges are refurbished and resold by the recycler. Other printer cartridge types that were not marketable were also collected and recycled for their plastic value by the recycler. In 2006, EHS recycled approximately 2,300 pounds of printer cartridges for a total \$1,000 donated to the Children's Inn. These cartridges were previously discarded in the municipal (non-medical) waste stream.

Late in 2005, a feasibility study was conducted for the future recycling of Styrofoam shipping boxes. These boxes are often discarded from shipments of biological samples. A compactor would be necessary to reduce needed storage space. EHS determined that the volume of Styrofoam generated was not sufficient to make Styrofoam recycling economically feasible.

The primary reason for the growth of EHS's innovative recycling programs is communication and outreach. The programs became popular once it was known that the proceeds from the recycling effort went to charity, and how little effort was required. The first step in communication was a simple mass emailing to the entire campus. Then EHS developed an interactive web page (Figure 5). The page graphically depicted all the locations of recycling drop off points via a map. Users could also view a menu of all the different recyclable materials and find out how to recycle each. The web page also has answers to frequently asked recycling questions. The web page can be found at <http://home.ncifcrf.gov/ehs/recycling/>. Finally, EHS set up a booth at the annual campus Spring Research Festival to promote the recycling program and web page. EHS continues to look for ways to improve the recycling initiative.

In conclusion, biomedical research facilities offer unique recycling options. Pipette tip boxes, Tyvek garments, and printer cartridges can be successfully recycled, as the recycling program at NCI-Frederick has shown. Recycling initiatives like these can be an added benefit to reduce the environmental impact of a facility.

As tougher environmental legislation is passed, and as fuel and production costs increase, the market and availability for recycling options should continue to grow.

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Figure 1.

Figure 2.

Figure 3.

Figure 4.

Figure 5.

Table 1**Recycling Volumes**

MATERIAL	YEAR	VOLUME
#5 Plastic Pipette Boxes	2003	7,176 pounds
	2004	12,958 pounds
	2005	9,262 pounds
	2006 ¹	15,396 pounds
	TOTAL	44,792 pounds
Tyvek Garments	2004	1,230 Pounds
	2005	1,726 pounds
	2006 ¹	915 pounds
	TOTAL	3,871 pounds
Printer Cartridges	2006 ¹	2,300 pounds
LMT - OFFSITE		
#5 Plastic Pipette Boxes	2003	800 pounds
	2004	2,546 pounds
	2005	1,706 pounds
	2006 ¹	2,345 pounds
	TOTAL	7,397 pounds

¹ 2006 totals are projected