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The Compost Activist: An Educational Website to Promote Composting

Paige Hasling

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The Compost Activist: An Educational Website to Promote Composting

Abstract
Any material thrown into the trash may contribute to global climate change (Fig. 1). This is alarming, since the US generates 250 million tons of Municipal Solid Waste (MSW) annually; per capita, each person generates 4.43 pounds of waste per day (EPA, 2012e). Some of this material is recycled or incinerated for energy, but most waste is discarded in landfills. The abundance of organic waste in landfills – food scraps, yard trimmings, leaves, textiles, paper and paperboard – is of particular environmental concern. Compostable materials that decompose without oxygen produce large quantities of methane gas as well as trace quantities of volatile organic compounds (VOCs). Although billions of federal dollars have been invested to harness this methane gas, experts debate if the capture rate is 17-20-49 or 75% (Brown, 2011). An effective strategy to avoid these toxic emissions is to divert recyclable and organic materials from landfill through recycling and composting. Composting is no longer a backyard initiative for gardeners; it is a climate change reduction strategy. However, a cultural shift is needed before composting is embraced as a sustainability strategy. Most composting experts agree that public education and outreach is needed to help individuals, communities and businesses separate organics from trash to promote national composting. Conclusive research has been published to prove the benefits of composting and mega-resources are available to promote composting. However, until now, there has not been a single, integrated website to guide concerned citizens from basic composting instruction, through the path of state regulation, and into the maze of policies and subsidies that shape the waste processing industry. After months of research, multiple in-depth interviews and a circuitous capstone journey, the culmination of this project is a website intended to transform a general environmentalist into a compost activist. Join the movement and visit www.compostactivist.org.

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THE COMPOST ACTIVIST:

AN EDUCATIONAL WEBSITE TO PROMOTE COMPOSTING

Paige Hasling

December 2012
dedicated to

the preservation of sacred old-growth trees
ACKNOWLEDGEMENTS

A journey of a thousand miles begins with a single step, and for me this capstone project was a quest. Searching for the environmental equivalent of the philosopher’s stone, I wanted to choose a project that could help transform pollution into paradise. And while the completion of this project is just a shadow of its intent, I am indebted to those friends who helped me try. I offer profound gratitude to those who walked miles of this journey with me, who held me when I stumbled and rejoiced when I got up. Life would be fruitless without such friends.

I would also like to thank the following faculty members who introduced me to new ideas, challenged me to think critically, and supported my circuitous explorations of environmental justice: Drs. Yvette Bordeaux, Sally Willig, Stan Laskowski, Robert Geigengack, Fred Scatena, Reginald Harris, Edward Chu and Dana Tomlin. I would also like to thank my coworkers and colleagues at the University of Pennsylvania, Department of Microbiology, who were always proud and patient as they watched me struggle to balance graduate school, work and life.

In addition, the following people deserve special recognition for providing professional guidance and feedback during the evolution of this capstone project:

- Tim Bennett – Owner, Bennett Composting
- Emily Marie Bush – MES Graduate, University of Pennsylvania
- Seth Budick – Manager, University City District
- Katherine Gajewski -- Director, Philadelphia Mayor’s Office of Sustainability
- Mike Giuranna -- Solid Waste Specialist, U.S. EPA Region 3
- Carl Hursh – Retired, PA Department of Environmental Protection
- Elaine Ingham – Senior Scientist, Rodale Institute
- Sue Macqueen – Executive Director, UCGreen
- Lee Meinicke – President, Philly Compost, Inc.
- Jeff Olson -- Solid Waste Specialist, PA Department of Environmental Protection
- Barrett Robinson – Senior Vice President, Pennsylvania Horticultural Society
- Phil Rodbell – Program Specialist, US Forest Service
- Tyler Weaver -- Waste Reduction Specialist, Children’s Hospital of Pennsylvania
- Nelson Widell – Owner, Peninsula Compost Group, LLC
- Marc Wilkin – Manager, Fairmont Park Organic Recycling Center

Lastly, I would like to thank my father for his quiet and faithful support throughout my academic career. I could not have done this without him.
ABSTRACT

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Paige Hasling

Advisors: Drs. Sally Willig and Yvette Bordeaux

Any material thrown into the trash may contribute to global climate change (Fig. 1). This is alarming, since the US generates 250 million tons of Municipal Solid Waste (MSW) annually; per capita, each person generates 4.43 pounds of waste per day (EPA, 2012e). Some of this material is recycled or incinerated for energy, but most waste is discarded in landfills. The abundance of organic waste in landfills – food scraps, yard trimmings, leaves, textiles, paper and paperboard – is of particular environmental concern. Compostable materials that decompose without oxygen produce large quantities of methane gas as well as trace quantities of volatile organic compounds (VOCs). Although billions of federal dollars have been invested to harness this methane gas, experts debate if the capture rate is 17-20-49 or 75% (Brown, 2011). An effective strategy to avoid these toxic emissions is to divert recyclable and organic materials from landfill through recycling and composting. Composting is no longer a backyard initiative for gardeners; it is a climate change reduction strategy.

However, a cultural shift is needed before composting is embraced as a sustainability strategy. Most composting experts agree that public education and outreach is needed to help individuals, communities and businesses separate organics from trash to promote national composting. Conclusive research has been published to prove the benefits of composting and mega-resources are available to promote composting. However, until now, there has not been a single, integrated website to guide concerned citizens from basic composting instruction, through the path of state regulation, and into the maze of policies and subsidies that shape the waste processing industry. After months of research, multiple in-depth interviews and a circuitous capstone journey, the culmination of this project is a website intended to transform a general environmentalist into a compost activist. Join the movement and visit www.compostactivist.org.
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INTRODUCTION

The seed idea for this capstone occurred when I first discovered a sapling rhododendron at the edge of Lake Lacawac in the Poconos in the summer of 2011 (Fig. 2). There was a large grouping of rhododendrons on the shore, but one of the seeds found shelter on a fallen nurse log. Growing moss had already started to soften the log, and the decaying bark was like a wet sponge for the fallen seed. I contemplated the cycle of renewal and decay, and thus began a journey into the world of nature’s nutrient cycle: composting. Billions of unseen microscopic organisms constantly recycle solid into soil, and without these decomposers, the planet would stagnate into a giant pile of trash.

Many people have lost their connection to nature; ecopsychologists lament for those who do not see the relevance of nature in their daily life (Cohen, 2007). Yet those who practice composting have found a way to reconnect to nature by linking waste disposal back to the earth. While landfills sequester nutrients in organic matter, composting returns nutrients back to the earth. It is an empowering act of global citizenship to release organic nutrients back to the soil; however, one obstacle to successful composting is that it is not as intuitive a process as some believe. Controlling biological decay is the key to a healthy planet, but it requires commitment and specialized training.

Compost is an elixir to soil; it helps soil retain water, sequesters carbon, prevents erosion, and reduces the need for pesticides (EPA, 2011b). It remediates the effects from blasting, compaction, and chemical contamination. And since composting is endorsed by the EPA as a preferred waste management solution, it has the potential to reduce greenhouse gas emissions by diverting organic materials from landfills, which produce large
quantities of methane gas. The scientific community has already proven the benefits of composting as well as the liabilities of landfill processing, yet landfilling still dominates the waste-processing industry.

My initial capstone was to propose a composting plan for the City of Philadelphia; however, after learning about their intent to wait for Waste Management Inc. to convert to a Bulk Handling System to process all MSW (BHS, 2012)( Gajewski, 2012), the project transformed into a website to promote compost activism at a national scale. As I interviewed composting experts, the same theme echoed: more educational outreach is needed to enlist public support. For decades, composting has been dominated by backyard gardeners and municipal facilities. However, if composting is to be accepted as a true competitor in the waste management industry, the public needs to examine its own trash habits, separate waste from organics, and demand more composting facilities to recycle organic material.

This project is unique because it demonstrates the social, environmental and economic impacts of composting; it shows how public support is needed to bring this sustainable practice of composting into the spheres of family, school, business and community. Until now, there has not been an integrated site to really explain how government regulation and subsidies have hindered the composting industry. Researching this project led me through a maze of state regulations regarding non-captive food waste, and into a political labyrinth where landfill-gas-to-energy (LFGTE) subsidies are decided and protected. At the end of the project I become convinced that composting is not just a backyard initiative for gardeners, but rather a climate change reduction strategy.
The US generates 250 million tons of trash each year, and more than half of it is compostable material: yard waste, food scraps and compostable paper (Fig. 3). When organic material is buried and compacted in landfills, the slow, anaerobic decomposition produces methane gas. Methane is an explosive greenhouse gas (GHG) that traps 21 times more heat in the atmosphere than carbon dioxide and significantly contributes to global climate change (EPA, 2010b). Even though the EPA has endorsed composting as the most sustainable disposal strategy (Fig. 4), landfill still dominates the industry (EPA, 2009). Processing organic waste in landfills produces 16% of national methane emissions (Fig. 5, 6) and 11% of global methane emissions; it also depletes the soil of nutrients.

Cities all over America have developed sustainability plans in response to President Obama's Executive Order 13514. In 2009, Mayor Nutter created Greenworks as a sustainability plan to make Philadelphia the greenest city in America (Nutter, 2009). One of its many aims is to reduce 70% of the 731,000 tons of Municipal Solid Waste (MSW). Philadelphia has already doubled its recycling rate, and the next challenge is to increase composting rates. There is a growing network of regional composters, and EPA’s WasteWise program is available to help commercial businesses and institutions convert to a system of source separation, because the first step to composting is separating organics from trash. Part I of this paper introduces composting services available in Philadelphia and nearby communities; Part II explains some of the complex policy positions that obstruct the growth of national composting; Part III introduces a website www.compostactivist.org. This website
The science of composting was first documented on tablets from ancient Mesopotamia; these tablets have been dated to the Akkadian Dynasty in 2120 B.C.E. The Greeks, Romans and Egyptians continued the practice of composting. The Bible and Talmud contain references to the use of rotted manure straw (University of Illinois, 2006). However, in the attempt to unlock the secrets of the soil, modern scientists of the 18th and 19th centuries tried to prove that water-soluble chemicals could replace the role of humus. Today, modern agriculture is dominated by chemical fertilizers to such a degree that it seems the practice of composting has disappeared along with family farms. However, the controlled practice of this primordial process endures in every city and community. Even in a large metropolis like Philadelphia, composting survives. This section describes various scales of composting facilities which help residents, schools, communities and businesses manage organic waste: large-scale, small-scale, on-farm, municipal and community composting. By understanding the varied models, it is possible to identify the counterpart in another geographic region.

**LARGE-SCALE COMPOSTING (PHILADELPHIA REGION)**

The largest composting facility east of the Mississippi is located in Wilmington, Delaware. Peninsula Composting, also called Wilmington Organic Recycling Center (WORC),
is a $20 million facility that collects and processes 550 tons of organic waste per day. Since 2009, grocery stores, restaurants and schools have been saving money by sending their food waste to WORC, where the material is transformed into finished compost in just eight weeks. It is convenient for trucks on I-495, trains on the Norfolk Southern Railroad, and ships entering the Delaware port; international shipments often arrive with 10 tons of spoilage to dump at the Wilmington location. (D. Sullivan & Goldstein, 2010). Villanova University, the University of Pennsylvania, Philabundance, Applebee's, Wawa Inc., and Whole Foods also send their source separated organics (SSO) to Wilmington for composting.

As the cost to landfill increases, source separation becomes a viable and cost-effective option for commercial businesses and institutions. Previously, it was very cheap to landfill everything; even a few years ago it was only $62/ton to landfill locally. Now, however, it costs $120/ton to landfill waste in Trenton and $85/ton in Philadelphia. In contrast, it only costs $40/ton to compost food waste at WORC, and $30/ton to compost yard waste. The limiting factor is often the distance between the waste generator and the compost facility; it is expensive to transport heavy organic waste. However, as the industry grows, there will be more compost facilities within close proximity to waste generators (Widell, 2012).

WORC is a state-of-the-art composting facility. Within hours of receiving waste matter, organic materials are shredded and formed into an Aerated Static Pile (ASP). Every day, a new 200-foot pile is created and covered by a $100,000 breathable GORE cover; the two-ton waterproof fabric allows CO₂ to exit but restricts water infiltration and odor releases (Fig. 7). Without this advanced in-vessel technology, WORC would have to manage
rain water as storm water rather than natural leachate. There are temperature and oxygen probes in every pile to monitor and control conditions. The piles are automatically ventilated when the oxygen level drops below 8% and is sprayed if the moisture level drops below 60%; these conditions accelerate the decomposition process and allow the temperature to reach above 170 degrees (Widell, 2012).

Nelson Widell is the owner of Peninsula WORC Facility. He has been involved with composting for 40 years and had previous experience with the advanced GORE technology. When he was approached in 2007 to open a compost facility in response to the Delaware state yard waste ban, he agreed on the condition that he be permitted to include food waste. As a founding member of the US Composting Council, he understands the problems of composting yard waste without food waste. His Beneficial Use Determination permit allows him to include pre- and post-consumer food waste, meat scraps and even road kill in his compost. However, Widell still struggles to obtain sufficient clean yard waste to balance the nitrogen/food materials since municipal subsidies direct most public yard waste to leaf composting facilities. While intended as a public service, municipal leaf collection programs make it more expensive for private composting firms to obtain sufficient carbon materials. So while Widell must charge less in order to obtain yard waste, he is adamant that the facility pay for itself from tipping fees, and he refuses to accept yard waste for free.

In fact, although Widell insists that the tipping fees cover the cost of doing business, the “icing on the cake” is that he is able to sell the finished compost at a good price under the name Gardener’s Choice (Widell, 2012). (D. Sullivan & Goldstein, 2010). And more recently the composting industry has qualified for a third revenue stream: carbon credits.
Since WORC diverts so much material from methane-producing landfills, the operation offsets a large volume of greenhouse gases (GHG). The EPA WARM tool allows users to quantify GHG savings, and WORC has successfully leveraged this information and registered with the Climate Action Reserve Program to bank carbon offset credits (MComb, 2009). Some of these credits are then sold to other companies wishing to offset their own carbon footprint (Widell, 2012).

**Mid-Scale, On-Farm Composting (Philadelphia Region)**

Ned Foley runs a two-acre composting facility in Royersford, PA called *Two Particular Acres*. He is both a farmer and a lawyer, and he is renowned as the first person in the state of Pennsylvania to obtain an on-farm General Permit 17 (GP17). His story begins in 2003, when he approached Pattie Olenick, a PA DEP Solid Waste Specialist, to explore ways to increase the organic content of his 37-acre farm; she was already working with the Rodale Institute to engage farmers in building regional compost capacity. Until then, state farmers had only been permitted to compost manure, animal waste and farm waste generated on-site. Without a special waste handling permit, they could not incorporate food scraps as a quality nitrogen source (Platt, 2010). The new GP17 permit allowed farmers to collect up to 500 tons of “pre-consumer food waste” (e.g. unsalable grocery store produce, vegetable trimmings, baked goods) to compost with their farm waste. The GP17 permit process was made simple and inexpensive, and it exempted farmers from expensive drainage requirements; this allowed them to create a loading pad with just sawdust (PADEP,
Partnering with grocery stores and food processors, farmers could increase revenues by producing and selling a high quality compost product in just a few months.

In 2004, Foley purchased a 100-horsepower tractor and a front-end loader with funds awarded from the PA DEP. The state funding was designated specifically to improve composting capacity, and Foley used his farm as a laboratory to experiment with compost technologies. He first experimented with traditional windrow piles; by 2006, he moved into ASP piles covered with finished compost as a biofilter (Fig. 8, 9). Next, he improved this method by attaching electric blowers to bored PVC pipes to keep the oxygen evenly distributed (Hetrick, 2011). This reduced odors as well as the liability of exposing tractors to corrosive conditions from turning the 5-foot tall piles and expedited the processing time. He also discovered that by replacing his trommel screener with an Airlift Separator to pull out plastic contaminates, he could separate and clean compost when it was still wet (Casey, 2011). Foley’s dedication to compost innovation puts him at the cutting edge of the industry. Most recently, he has partnered with H&K Group and American Biosolids to enlist quarry owners into the business (Pacheco, 2011). Quarry operators have access to large amounts of rock dust and clay, and Foley has discovered significant benefits from using this material as a natural biofilter; the bulking agent helps create greater oxygen availability and controls excess heat buildup (Sullivan, 2004). With the right model, he believes a network of smaller facilities can process the city’s food waste.

As an on-farm composter, Foley appreciates the benefits of using finished compost. Within the first year of applying compost to his farmland, his annual fertilizer bill dropped from $5,000 to $500. He also reflects that before the compost venture, there was almost no
wildlife on his property; after just a few years of composting, he now sees groundhogs, hawks, herons and eagles drinking from his stream and earthworms proliferating in his soil. Foley says, “Soil is the foundation of life; it is almost like magic when you see the change in the soil” (Hetrick, 2011).

**Municipal Leaf Composting (Philadelphia Region)**

Philadelphia’s Fairmont Park Organic Recycling Center (FPORC) was established in 1989 to comply with PA Act 101, a new state law requiring municipalities to divert yard waste and recyclables from landfills. Since then, Philadelphia has had a legal obligation to collect and compost leaf waste, and landfill operators have had a legal responsibility to reject this material from incoming trucks. In accordance with Section 271.103(h) of the state municipal waste regulations, FPORC operates a 5-acre plot on a PA DEP Permit-By-Rule (PBR) agreement. The City Streets Department transports 3,000-6,000 tons of yard waste to FPORC each year (Wilkin, 2012).

FPORC uses a Scarab windrow turner to mix and aerate their six long windrow piles (Fig. 10); they use a Royer trommel screen to sift out the non-organic contaminants found in municipal leaf collections. However, the old equipment frequently malfunctions and in 2006 it was beyond repair. FPORC is under the umbrella of the Philadelphia Streets Department, but it did not have sufficient resources to procure a backup system to handle equipment failure. Since the City is legally obligated to ensure the organic waste is not landfilled, taxpayers were required to have the materials transported by truck and composted at the
nearest facility in Bucks County\(^1\). The heavy trucks only get 3 mpg, and the facility charges a $37/ton “tipping” fee to accept yard waste. Since FPORC barely composted any materials in 2006, it is possible that 3,500 tons of organics was transported to Tullytown; the malfunction likely cost taxpayers $130,000 (Gannett Fleming, 2008).

In 2007, FPORC commissioned a report to independently assess the composting facility’s needs and responsibilities. Gannett Fleming’s 31-page report recommended the City invest in the composting facility by purchasing a self-propelled windrow turner, a new trommel screen, and a horizontal grinder. The turner is needed to aerate the compost pile, the screen is needed to removed plastics and trash, and the grinder is needed to manage tree trunks and branches. Although it would cost a million dollars to modernize and optimize the facility, the report recommended FPORC apply for state funding through PA DEP Act 101 Section 902 Recycling Grant Funds and PA DEP Act 101 Section 904 Recycling Performance Grants. These state funds are earmarked to subsidize municipal recycling and composting initiatives. However, even without grant funding, a new marketing strategy could make FPORC financially independent. According to their reports, in 2011, they gave away $155,920 of compost material and subsidized another $57,875 of organic materials to local landscaping businesses (Fig. 12).

It is likely that Philadelphia taxpayers would vote to expand the FPORC composting capacity if they understood the environmental and legal importance of municipal composting. With more public support, FPORC would have the option to upgrade their PBR status to a Beneficial Use General Permit 30 (GP30) and expand their yard waste facility

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\(^1\) Tullytown Resource Recovery Facility is 25 miles from Philadelphia. This facility is owned by Waste Management, Inc. and it is the location where yard waste must be processed if the Fairmont site malfunctions.
from 5 acres to 15 acres (PADEP, 2012). That would allow them to triple their output from 1,500 tons/year to 4,500 tons/year. Unfortunately, without incorporating food waste as a nitrogen source, it would be impossible for the City to produce a higher quality compost product.

The yard waste bans of the 1980s jump-started the composting industry, yet the public expectation that high-carbon waste could produce a high-quality product has handicapped the industry. Since mishandled food can be a pathogenic danger, state regulations control the process of collecting and processing food waste. Obtaining a General Permit 25 (GP25) to include food waste with municipal yard waste is extremely difficult (PADEP, 2010). For decades the FPORC compost recipe was one part manure with five parts leaf waste. This high-carbon mix lacked the nitrogen needed to generate decompositional heat; although it was a low-risk recipe, it could not produce high-quality compost. Recently, FPORC started a small pilot program to include some captive food waste (Wilkin, 2012); under this program they can process small quantities of “captive food waste” (i.e., food that is generated and processed within park limits), but they would need a GP25 to expand the program.

Philadelphia’s ambitious Greenworks program includes such goals as a 70% reduction of the total 731,000 annual tons of MSW by 2020, a 20% reduction of total GHG emissions, and improved storm water management to meet Federal standards. All three of these aims would benefit from increased composting. According to the EPA’s Waste Reduction calculator, if the City diverted 25% of organic waste from traditional processes to composting, the municipal carbon footprint could be reduced by 56,538 MTC02E; this
reduction would be equivalent to saving 5.7 million gallons of gas (Fig. 13). Diverting organic materials toward composting also promotes green infrastructure; each bucket of compost incorporated into urban soil reduces soil compaction (EPA, 2011b). Compacted soil leads to increased erosion, stormwater runoff and flooding; it reduces the pore space necessary for movement of air and water and is a serious environmental problem for urban landscapes (Biala, 2011). Investing in FPORC could help the City lower MSW costs, reestablish healthy ecosystems, and become the greenest city in the nation.

**SMALL-SCALE COMPOSTING (PHILADELPHIA REGION)**

Bennett Compost is a small composting service in Philadelphia that caters to residents and businesses. Bennett’s residential model is particularly innovative and could be replicated in any densely populated region. He provides a 5-gallon bin to his environmentally-minded clientele, and charges $15/month to have organic material picked up every fortnight. To expedite the process, customers place their bins on the curb, and he collects the material between 9PM and 6AM. The late-night pickup allows him to avoid traffic; in densely populated neighborhoods, he can collect bins from 20-30 houses in one hour (Bennett, 2012).

Each week, Bennett collects 3,000 pounds of food scraps from 330 residential customers. He manually processes this residential material at six designated community garden sites in South Philadelphia using the triple-bin system. He builds the compost bins with scrap wooden pallets and keeps the piles covered with a tarp. He meticulously cares for compost critters by monitoring the oxygen:water and carbon:nitrogen ratios in the piles.
He collects leaves in the fall season and warehouses them for use throughout the year; he depends on leaves and sawdust as primary carbon sources. His theory is to focus on aeration rather than particle size; by manually turning the piles twice per week he is able to avoid the labor of cutting large pieces into small pieces. He aims to get his piles to a temperature of 121 degrees to maximize the diverse biotic population, and by following best practices, his raw waste material transforms into compost in just a few months (Bennett, 2012). Gardeners call his high-quality compost “black gold.”

Bennett cannot legally sell his finished compost in stores; however, one of the perks of subscribing to his service is that he returns some product to residential customers. The remaining material is given back to the community gardens in exchange for using their land. This arrangement at least partially conforms to the “captive-on-site model”, since the compost is used in the same place where the feedstock was produced and processed. Although even the community garden model of post-consumer waste is not exempted by state law, the composting service benefits the community by reducing MSW and by cycling waste nutrients back to the soil.

**COMMUNITY COMPOSTING (PHILADELPHIA REGION)**

The Dirt Factory is a recent initiative by University City District (UCD) to promote community composting in West Philadelphia; it began when the University of Pennsylvania donated two “Earth Tubs” to make room for the replacement Biobin® Organic Collection Systems. UCD identified an abandoned lot at 43rd and Market and partnered with the owner to create the community space with minimal investment. Solar panels and an outdoor
generator were installed to operate the two in-vessel Earth Tubs, and felled trees were cut to create an outdoor seating area for community classes. Since the June 2012 grand opening, the bins have been filling up with local organic waste. UCD has partnered with Pedal Coop, a local startup business that transports residential food by bicycle pedal power. In exchange for the convenient location to bring food waste, they help operate and aerate the Earth tubs. Also, residents are able to drop off food waste free of charge on Wednesday between 5-6 p.m.; no membership is required.

Earth Tubs are in-vessel composters designed for low volume generators. They are popular among schools that operate captive facilities and qualify for federal funding. The units retail at $10,000, and can accommodate 100 - 200 pounds of material per day. The 300-pound tub utilizes an auger to mix materials; although the large auger is turned manually, it needs power to operate. Organics need to be turned twice per week for 15-minute intervals to maintain a healthy aerobic process; the system has a blower which draws out heated air and odorous gases through a biofilter. The advantage of running two units simultaneously allows a constant flow of collection, production and curing; one bin can complete the composting process while the other is being filled (Budick, 2012).

**SUMMARY OF PHILADELPHIA MODELS**

This grid summarizes the examples discussed. It is not an exhaustive list of regional composting services, but the table highlights the relationship between permit type, material restriction and processing temperature. It also shows the connection between the hauler and processor for residential, commercial and municipal clients in the Philadelphia region:
<table>
<thead>
<tr>
<th></th>
<th>Hauler/Transporter</th>
<th>Destination Facility</th>
<th>Compost Facility – Permit</th>
<th>Monthly Tons Diverted</th>
<th>Material Restrictions per Permit</th>
<th>Monthly Rate</th>
<th>Temp of Compost Pile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Services</td>
<td>Bennett Compost</td>
<td>Local Garden</td>
<td>None</td>
<td>6</td>
<td>Meat/Dairy</td>
<td>$15/month + dirt</td>
<td>121 degrees</td>
</tr>
<tr>
<td>Pedal Coop</td>
<td>UCD Dirt Factory</td>
<td>None</td>
<td>0.5</td>
<td></td>
<td>Meat/Dairy</td>
<td>$10/month</td>
<td>Un-monitored</td>
</tr>
<tr>
<td>Residential Services</td>
<td>Bennett Compost</td>
<td>UCD Dirt Factory</td>
<td>None</td>
<td>?</td>
<td>Meat/Dairy</td>
<td>Free</td>
<td>85-130 degrees</td>
</tr>
<tr>
<td>Commercial Services</td>
<td>Bennett Compost</td>
<td>Peninsula (WORC)</td>
<td>Beneficial Use</td>
<td>25</td>
<td>None</td>
<td>Bid for contract</td>
<td>168 degrees</td>
</tr>
<tr>
<td>Waste Management</td>
<td>Bennett Compost</td>
<td>Two Particular Acres</td>
<td>GP17</td>
<td>25</td>
<td>None</td>
<td>Bid for contract</td>
<td>135-162 degrees</td>
</tr>
<tr>
<td>Waste Management</td>
<td>Pedal Coop</td>
<td>UCD Dirt Factory</td>
<td>None</td>
<td>0.75</td>
<td>Meat/Dairy</td>
<td>Bid for contract</td>
<td>85-130 degrees</td>
</tr>
<tr>
<td>Municipal Services</td>
<td>Waste Management</td>
<td>Peninsula (WORC)</td>
<td>Beneficial Use</td>
<td>7,000</td>
<td>None</td>
<td>Bid for contract</td>
<td>168 degrees</td>
</tr>
<tr>
<td>Streets Dept.</td>
<td>Fairmont Park</td>
<td>Exempt</td>
<td>350</td>
<td>(Yard waste only)</td>
<td>Taxpayer dollars</td>
<td>?</td>
<td>?</td>
</tr>
</tbody>
</table>

A non-regional reader may search for composting services by zip code at Biocycle’s “Find a Composter Site” (Biocycle, 2012) and contact haulers which are contracted with the compost facility. For additional resources and support for converting to composting, visit [www.compostactivist.org](http://www.compostactivist.org).

**PART II: STATE AND FEDERAL ISSUES**

Composting is the waste management solution endorsed by the EPA (EPA, 2011c), and so it should not be cast as merely a backyard initiative for gardeners. The world cannot afford the environmental liabilities from landfill: 1) methane gas emissions, or 2) soil nutrient depletion from sequestered organics. Composting is a powerful GHG reduction strategy; Germany and Denmark have already banned organics from landfill, and other countries have implemented voluntary or partial bans. There is already an effort underway to make Massachusetts the first state in the union to ban pre-consumer food waste from landfill (MA DEP, 2012).
Although it may seem that policy and culture are beginning to converge on the issue of composting, the following three issues explain why landfills may continue to dominate the waste management industry for decades to come.

**Methane Gas Controversy**

Methane gas is produced when non-hazardous Municipal Solid Waste (MSW) is stored in landfill. It is an explosive gas, and it traps 21 times more heat in the atmosphere than carbon dioxide (EPA, 2010b). Organic materials decompose in the presence of biotic microorganisms, yet landfills are inherently vacuums, and deprive microorganisms of oxygen. As organic materials decay through a process of anoxic decomposition, they produce methane and other toxic GHG.

Most national waste is processed in a landfill. For decades, landfills emitted methane gas without state or federal regulation (Ewall, 2007) (Fig. 1). While individual states could enact laws to control materials collected at landfills, only the EPA could regulate toxic air emissions. After years of debate, in 1994 the Federal EPA required large landfill operators to comply with the Clean Air Act and control methane emissions; this was part of a compromise to fulfill the goals in the Climate Change Action Plan (EPA, 2011a).

Simultaneously, the EPA initiated the Landfill Methane Outreach Program (LMOP) (EPA, 2012d) and classified landfill gas as a renewable energy source (EPA, 2012b) (Fig. 14). Garbage was viewed as useless and ubiquitous; instead of trying to reduce the national volume of waste, the program sanctified waste as a by-product of society and recognized methane gas production as a legitimate and renewable energy source. To encourage landfill
operators to capture and transfer the methane gas to the national grid, the LMOP program subsidized 30% of the LFGTE equipment costs. And once the equipment was installed, landfill operators could sell the captured gas and also bank the carbon offset credits (Marciano, 2011). EPA claimed that LFGTE could capture 75% of methane from 59% of methane emissions (EPA, 2012c). So far, the federal government has awarded almost $2 billion in LFGTE subsidies (Marciano, 2011), and thirty states now use it as part of their renewable energy portfolio (Williams, 2008).

The LMOP program was intended to discourage landfill operators from just fluming off the methane gas to comply with EPA regulations. While fluming the gas would have reduced 99% of organic compounds and convert methane into CO₂, a less potent GHG (US CDC, 2001), it would also produce dioxins during combustion (Williams, 2008). So although the intent was always to reduce methane gas emissions, a 2010 report issued by the Sierra Club shows that the reliance on LFGTE has only increased overall GHG emissions (Vincent, 2010) (Pelley, 2009). The Intergovernmental Panel on Climate Change (IPCC) reports that leaks, malfunctions, and delayed installation dates vary the landfill gas capture rate range from 20-70% (Oonk, 2010). BioCycle Magazine and the American Chemical Society (ACS) have also published articles which refute the EPA’s methane capture claims and dispute the rationale for federal investments. So although it is possible that lowering methane emissions is best achieved by an integrated approach that employs all available technologies, it seems that billions of dollars of investment in LFGTE is only perpetuating the landfill industry (Rigley, 2005).
The Humer-Huber graph best illustrates the variable methane capture rates during a 50-year period; the grey portion shows the unrecovered methane gas (Fig. 15). Methane production is at its peak when the LFGTE system is installed; the 10-year period before the landfill is capped may be the most toxic period (Oshins, 2008).

Basic laws of chemistry prove that burying organic waste produces methane gas; landfills should never have been allowed to dominate the waste processing industry. The LFGTE technology was heralded as a way to mitigate GHG from old landfills and convert that waste into energy (EPA, 2010a), but why suffer the side effects of a cure rather than convert to a sustainable process? LFGTE provides less than 0.5% of national energy, and the LMOP program has allowed the landfill industry to keep control of organic waste.

In 1979 there were 18,500 landfill sites; many of these sites were owned by municipalities. After the EPA RCRA Subtitle D regulations were established to control liners, leachate and runoff, there was a trend to close landfill sites. By 1990, only 6,300 landfill sites remained, and by 1996 this dropped to 1,275 open sites. The overall percentage of landfill sites has dropped from 84% to 69% since 1989 (Fig. 16), and with the help of state and federal regulations, there has been a noticeable shift from landfill to recycling. However, landfills continue to emit methane gas, there is no regulation to support diverting organics from landfill. And the composting industry does not have the power to divert half of the national waste from landfill. Therefore, public education is needed to explain the externalized costs associated with waste disposal; a dual campaign is needed to reduce overall waste and to divert organics from landfill.
Yard Waste Ban Controversy

Municipal composting flourished between 1986 and 1993, after twenty-seven states banned yard waste from landfills (Fig. 17). The EPA reports that 57% of yard trimmings were composted (EPA, 2012f) after cities were required to implement leaf collection programs. Yard waste bans were the motor of the budding composting industry (Buckner, 2011). State environmental agencies helped by exempting municipalities from the burdensome permit process; since leaves decompose without pathogenic threat, leaf composting was not a threat to public health. Cities purchased land and equipment to compost yard waste. Most of these facilities were able to accept manure waste (a nitrogen-rich source) to balance the leaf waste (a carbon-rich source), although almost none of these municipal facilities are permitted to include nitrogen-rich food scraps. Since the diversity of feedstock for municipal composting is limited, and the C:N is often too low to generate sufficient heat, the final compost product was a lower quality. However, when the yard waste bans were enacted, the only goal was to extend landfill capacity by reducing the volumes of yard waste.

The expansion of Landfill Gas to Energy (LFGTE) has impacted the composting industry. Landfill operators receive income from methane gas captured at their facility, but in order to power the equipment, they need to control the waste (Wheatley, 2010). Therefore, since 2003 the landfill lobbyists have been fighting hard to repeal yard waste bans (Geraty, 2011). Since the energy produced with landfill gas is dependent upon the feedstock tonnage, landfill operators are looking back at yard waste for cheap material. Their argument is that bans were enacted when landfill capacity was limited; now they are
fighting on the grounds that LFGTE is a green technology and should be funneled to landfill operators as an energy supply (Csapo & Lindenberg, 2008). Landfill lobbyists have tried to repeal yard waste bans. Specifically Florida in 2010, Missouri in 2009, Georgia and Michigan in 2008, and Iowa in 2003 have voted to repeal the ban. The conflict between composting and energy endures as states attempt to strengthen their renewable energy portfolio with LFGTE (Buckner, 2011).

The yard waste ban upset another group of people, too -- for an entirely different reason. Although the bulk of the new composting capacity was from municipalities, other niche composting companies developed to create larger scale projects. In order to create a quality compost product, a diverse feedstock of carbon and nitrogen is needed. It is important to aim for a C:N ratio around 30:1 to reach the high temperatures that state permits require. If a pile has too much carbon it will take longer to compost and if a pile has too much nitrogen it will putrefy. Professional composters need to balance their recipes to accelerate decomposition and avoid neighborhood complaints. However, some professionals resent that municipalities are paid to collect and compost leaves with taxpayer money. The cities do not have permits to include food waste and the private businesses which have the food waste permits are disadvantaged by having to pay higher prices for sufficient carbon/leaves to balance their nitrogen/food waste.

There are two reasons why subsidized municipal leaf collection hurts professional composters. First, obtaining a state permit to accept pre- and post-consumer food scraps is an expensive and rigorous process, but once this hurdle is achieved the composters need to procure sufficient carbon to balance their available nitrogen feedstock. While many cities
collect this carbon source from taxpayer funds, a compost facility has to pay for leaf waste. Even if they can find a free source of leaf waste, they need to pay for the transport to their location, which often involves a significant distance. Therefore, the compost facility has to make difficult business decisions: 1) compromise on their C:N ratio, 2) pay for carbon waste, or 3) accept less food waste from businesses with which they have contracted. Although the national waste could be composted together with a balanced C:N ratio, it is important that each composting facility gets equal access to the materials (Castagnero, 2011).

Professional composters are also burdened by the risk of accepting contaminated feedstocks. Science has recently proved that some chemicals persist through the composting phase (D. Sullivan, 2012) (Monbiot, 2011). To avoid the risk of producing toxic compost, professional composters sometimes need to reject grass clippings and yard waste that have been treated with herbicides and fungicides.

The proliferation of toxic chemicals is a danger to the composting industry, especially for smaller facilities, which struggle to reach the thermophilic temperature range necessary to eradicate these toxins. Municipal facilities are most at risk because the lack of nitrogen keeps their carbon-rich piles processing at a lower temperature. Cities are required to process leaf waste, and they cannot reject material for fear of contamination. So although some cities test the finished compost before offering it to residents, others have been sued for damages by residents whose gardens have suffered from the toxic compost. Municipalities now sell some of their material to businesses and gardening stores, so the public needs to always research the source of the soil amendments they use. If the Home Depot label says “Do not use on vegetables; for flower use only,” it is an indirect warning
that the compost could have been made with contaminated feedstock. Consumers can lose faith in compost after using a product contaminated with a lethal persistent chemical. Although the benefits of quality compost are indisputable, not all decomposed matter is healthy compost. Therefore it is important to be a compost connoisseur and support quality processing facilities.

**LIFE CYCLE ANALYSIS MODELING CONTROVERSY**

Another issue that threatens the composting industry is an esoteric concern of how Life Cycle Assessment (LCA) tools are designed. A LCA is a common way to model and compare resources involved with extraction, production, distribution and disposal for a particular item or process (Fig. 18). LCA tools have the power to change the world because they are considered consistent, reliable and scientific tools which global leaders rely on when making policy decisions.

The EPA Waste Reduction Model (WARM) was developed as a modeling tool to compare GHG emissions between four primary disposal methods: recycling, landfill, combustion and composting. The comparative calculations are based on rigorous LCA data. However, every LCA tool relies on inference; it is important to understand the disclosed assumptions that drive EPA’s WARM analysis:

WARM assumes that buried organic waste is a form of carbon storage (EPA, 2012c); it differentiates between food scraps and yard trimmings only because of the change of decay rate effects the sequestration. According to the EPA, “the net GHG emissions from composting are lower than landfilling for food discards (composting avoids CH₄ emissions), and higher than landfilling for yard trimmings (landfilling is credited with the carbon storage that results from incomplete decomposition of yard trimmings) (EPA, 2006). This assumption comes from an experiment that shows only 28% of leaf mass and 29% of branches decomposed in a landfill environment, as compared to 94% of grass and 84% of food waste (Oshins, 2008).
WARM is a user-friendly tool used by food generators, mayors and moms to quantify the liability of waste processing. It is the standard model to compare waste disposal methods, yet the emphasis is on GHG emissions. It does not model the environmental benefits associated from using finished compost, and neither does it model the benefits of reduced pesticide use (Morawski, 2008). It does model the carbon sequestration of each method, and it is shocking to learn that the International Panel of Climate Change (IPCC) calculates the carbon sequestration of a dead tree to be equal in value to the carbon sequestration of a live tree (IPCC, 2012). The assumption is that as long as a tree does not decay, the atmosphere is protected from the release of CO_2_ GHG; this assumption denies the role of nutrient cycling and the earth’s need to retain its nutrients in a closed-loop cycle.

Landfill operators capitalize on EPA’s WARM assumption and claim that it is beneficial to landfill yard waste because it sequesters carbon in an anthropogenic carbon sink. Although the research in this paper has already discussed the liabilities of methane production, it is no surprise that the landfill industry tries to influence the assumptions of LCA modeling tools. The quote below shows how Waste Management, Inc., the largest waste processing company in the country, continues to leverage the LCA benefits of landfill as a carbon sequestration solution to gain additional benefits at the state level:

“Landfills are a known source of methane and other greenhouse gas emissions, but did you know they also store significant amounts of carbon? This storage, or “sequestration,” is important because it removes carbon from the natural carbon cycle indefinitely, reducing net emissions of greenhouse gases. Carbon is naturally removed from the atmosphere and stored in forests (and then in harvested wood products, e.g., paper, lumber, furniture), yard trimmings, and food scraps via photosynthesis. Once these materials are disposed of in a landfill, only a portion of them will decompose, while a portion will remain stored in the landfill indefinitely. Decomposition of the waste creates landfill gas, which is primarily composed of methane and carbon dioxide, as well as small amounts of volatile organic compounds. The proportion of the solid waste in landfills that decomposes depends on the type of waste, the amount of moisture, and other factors that affect the growth of microbes that break down the waste, and whether the landfill is operated to retard or enhance waste decomposition. The landfilling of harvested wood products, yard trimmings, and food scraps stores a significant amount of carbon that
would otherwise decompose and release carbon to the atmosphere. Thus landfill carbon storage should be accounted for in greenhouse gas inventories. The Intergovernmental Panel on Climate Change recommends doing so and the EPA follows that recommendation in preparing the annual U.S. national greenhouse gas inventory by accounting for carbon storage associated with disposal of harvested wood products, yard trimmings, and food scraps in landfills. For the sake of transparency, comparability, consistency, and completeness, we believe that all state inventories should do the same (Waste Management Inc., 2012).

EPA’s WARM also asserts that 59% of methane produced at facilities with Landfill Gas-to-Energy (LFGTE) is captured and used for electricity (EPA, 2011a). Despite contrary research published by the IPCC showing that LFGTE systems only capture 20% of methane emissions, and another international report that concluded methane emissions simply cannot be accurately measured (Oonk, 2010), the WARM model uses the 59% assumption to make waste management comparisons between composting, landfill, incineration and recycling. LCA cannot accurately reflect this technology because there are inefficiencies attributed to late installation, leaks, improper usage and faulty technology (IPCC, 2011). Yet despite this controversy, EPA’s WARM model continues to use 59% in the calculations and affect global waste management decisions.

Morris Environmental Benefits Calculator (MEBCalc) is an alternate LCA tool used to assess the impact of waste disposal methods on the categories of climate change, human health, eutrophication and acidification (Fig. 19). The comprehensive analysis includes data from 1) EPA’s WARM model, which measures GHG emissions, 2) EPA’s Tool for the Reduction and Assessment of Chemical Impacts (TRACI), which measures the environmental impact of 900 different chemical pollutants, 3) EPA’s Municipal Solid Waste Decision Support Tool (MSW-DST), which emphasizes the costs of transportation, energy and material markets, and 4) peer-reviewed journal articles (MADEP, 2008). To fully quantify the cost of disposal, MEBCalc assigns a monetary value to each criterion, including the upstream
pollution prevention costs from reduced fertilizer use (Fig. 20). Using the MEBCalc method, the region of Niagara, Ontario shows a net economic benefit from composting between $1.4 million to $5.8 million per year (Morawski, 2008).

However, the modeling tool that is being exported globally to make waste management decisions is the MSW-DST. This tool models emission associated with collection, transportation, energy and 30 air- and water-borne pollutants; the analysis emphasizes the low cost of land, the high potential for LFGTE electricity, and the convenience of existing landfill sites. The analysis does not measure the benefit of composting, and the criteria favor landfilling. Landfill is already the dominant waste management strategy (Fig. 21), and MSW-DST is assisting the global export of LFGTE technology.

**PART III: WEBSITE OVERVIEW**

The final section of this project introduces the culmination of this capstone journey: a website with the URL [www.compostactivist.com](http://www.compostactivist.com). The website is designed to immerse the reader into the world of composting: it is a warehouse of information. Many visitors are astounded at the volumes of articles available on the subject as well as the complexity of issues. While it is my hope that this website inspires more national composting, it would be enough if it causes people to reflect on their own waste habits. Waste management is a significant global issue, and it is important for people to reduce, reuse and recycle. And it is time to prioritize organic recycling and realize that composting is a climate change reduction strategy.
Designing the website was an exciting process, and it was challenging to translate
the academic research into a public resource. Significant time was invested to identify the
most compelling resources; each page summarizes issues and links to articles,
commentaries, games and movies. The website was written in ASP.NET using Visual Web
Developer 2010 Express, and multi-media resources are included to engage the reader. The
sitemap and sample web pages are located in the appendix (Appendix 1).

The target audience for this website evolved from food waste generators to
environmentalists. Although restaurants, institutions and food processors generate and
control the largest volume of pre-consumer food waste, they do not utilize existing EPA
resources to divert organics to composting. Therefore, it is my hope that an educated public
can bring the online tools and resources to the attention of the business community. The
website exposes environmentalists to varied compost solutions and online tools for schools
and businesses; with this information, they can directly promote local compost solutions.
By understanding the compelling political issues that affect the waste disposal industry, an
educated public can help build an infrastructure to promote national composting.

The Homepage introduces issues of waste management, similar to the introduction of
this paper. It encourages the user to discover both how and why to compost.

Be an Expert teaches the basics of backyard composting and links to the top ten
composting guides. Although the concepts of composting are simple, there are many ways
to fail. This section links to an original resource guide that matches concepts with online
games, movies and lessons. This section also includes dozens of articles to educate the
reader on the scientific benefits of compost.
BE AN ACTIVIST offers resources for those wanting to help businesses and schools start a composting system. Without over-simplifying the concerns involved with collecting, processing and transporting food waste, the comprehensive checklist and guides explain the process: perform a food waste audit, form a composting committee, consider bin designs, contact local and state officials as needed. The section targeted towards schools further specializes to offer age-appropriate resources for elementary schools, high schools and colleges. The section targeted towards the business community links to sophisticated EPA tools to analyze the costs and benefits of composting. These underutilized resources guide food generators to perform a waste audit and use the data quantify the benefits of implementing a composting system. The tools help determine if on-site or off-site composting would be financially advisable.

This section also includes the political issues presented in this paper: 1) landfill gas subsidies, 2) yard waste bans, and 3) life-cycle analysis tools. However, the website version links to articles, videos and resources.

BE AN ENTREPRENEUR is designed to entice activists to build compost capacity by processing, hauling and organizing events to divert organics from trash. Many resources developed by Cornell University are presented, as well as an excellent link to the “On Farm Composting Handbook” developed by the United Nations. There are several long videos to educate the user about large scale composting methods, and while this section will have less appeal, it is important for all users to understand the potential of large scale composting as a global waste management solution.
Organic waste does not automatically decay, and managing the composting process requires specialized knowledge. Decomposition depends upon the life cycle of biotic microorganisms. Fungi and bacteria are the backbone of a healthy planet; without these decomposers, the earth would be a giant pile of trash. Food, plants, clothes, furniture, books and textiles are sequestered resources on loan from the earth. Because traditional waste processing does not return these organic resources to the soil, landfilling amplifies the effects of flooding, erosion, and drought and also increases the dependence upon chemical fertilizers and pesticides to manage soil fertility.

While cities, businesses and institutions have begun to realize the environmental, social and economic benefits of diverting organics from trash, there is not yet enough capacity to compost waste on a national level. Methane gas subsidies have empowered landfill operators and municipal leaf processing laws have disadvantaged compost operators. Therefore, without public support, the composting industry cannot compete for waste against established processors.

In 2007, Annie Leonard released her famous video called Story of Stuff; it brought public attention to the unsustainable cycle of extraction, production, consumption and disposal, and it inspired environmentalists to close the loop on the linear cycle of "stuff." It is time for that public awareness to expand to include the unsustainable link of processing waste in landfills. More people are needed to make a clarion call to promote composting within the waste management industry.
## FIGURES

### Exhibit A-1

<table>
<thead>
<tr>
<th>Material</th>
<th>Source Reduction</th>
<th>Recycling</th>
<th>Composting</th>
<th>Combustion</th>
<th>Landfilling</th>
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</table>

*Note that totals may not add up to rounding, and more digits may be displayed than are significant.*

NA: Not applicable, or in the case of composting of paper, not analyzed.

*Source reduction assumes initial production using the current mix of virgin and recycled inputs. Includes emissions from the initial production of the material being managed, except for food waste, yard waste, and recyclables.*

---

**Fig. 1**

Note that EPA’s Life Cycle Analysis (LCA) assumes recycling, composting and source reduction produce negative greenhouse gas (GHG) emissions. It also assumes that both organic and non-organic materials produce GHG from a raw materials extraction point of view.

Finally, note EPA’s LCA tables credit landfilling food discards, and yard trimmings with negative GHG emissions. Although the explanation for this is discussed in Part III of the paper, it is curious how landfills can both produce 16% of national methane as well as sequester GHG (EPA, 2006).

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**Fig. 2**

Rhododendron sprouts from a nurse log. Photo taken during class field trip in the Poconos, 2011.

**Fig. 3**

More than half the 2010 Municipal Solid Waste (MSW) is compostable (EPA, 2012a).
Fig. 4 EPA endorsement of composting as waste management solution (EPA, 2012).

Fig. 5 Anaerobic landfills produce 16% of national methane emissions (EPA, 2010b).

Fig. 6 Food waste is heaviest waste material; 33.79 million tons of food was discarded in 2010 (EPA, 2012a).
Fig. 7 Aerial view of 56 CORE covered piles at Peninsula compost facility in Wilmington, Delaware.

Fig. 8 Forced Aerated Static Pile (ASP) design using finished compost as a biofilter (Mishra, 2003).

Fig. 9 Aerial view of wide ASP piles at Two Particular Acres in Royersford, PA (Google maps).

Fig. 10 Aerial view of 6 windrow piles and leachate pond at FPORC (Gannett Fleming, 2008).
Fig. 11 FPRC equipment failure in arrested municipal composting in 2006. To comply with PA Act 101, the City had to pay to transport and process materials to Waste Management Inc, Tulleytown facility. (Gannett Fleming, 2009)

Fig. 12 FPRC outputs: compost, mulch, woodchips, logs and grass. In 2011, actual sales were only $57,875 however an additional $155,920 of material was given away for free to local residents. There is an industry debate over the effect of municipal giveaways. (Gannett Fleming, 2008)
Fig. 13 EPA’s Waste Reduction Modeling Tool (WARM) compares GHG emissions for alternate waste disposal scenarios. This example shows potential GHG savings if Philadelphia diverted 25% of organic MSW to composting (EPA, 2012a).

Fig. 14 Landfill Gas to Energy Technology (EPA, 2012g).

Fig. 15 Gray area shows uncaptured methane gas from LGWTE technology over a 50-year period. Most of the methane gas is produced and released before the landfill cap is installed (Oshins, 2008).
Table 1. State of Garbage in America survey data 1989–2006: Reported and estimated MSW generation and rates of MSW recycling, waste-to-energy and landfilling

<table>
<thead>
<tr>
<th>Year of Data</th>
<th>Reported MSW Generation (tons/yr)</th>
<th>Estimated MSW Generated (tons/yr)</th>
<th>MSW Recycled (%)</th>
<th>MSW Waste-To-Energy (%)</th>
<th>MSW Landfilled (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>269,000,000</td>
<td>8.0</td>
<td>8.0</td>
<td>84.0</td>
<td>77.0</td>
</tr>
<tr>
<td>1990</td>
<td>293,813,000</td>
<td>11.5</td>
<td>11.5</td>
<td>76.0</td>
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<td>1991</td>
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<td>14.0</td>
<td>10.0</td>
<td>72.0</td>
<td>67.0</td>
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<tr>
<td>1992</td>
<td>291,472,000</td>
<td>17.0</td>
<td>11.0</td>
<td>71.0</td>
<td>67.0</td>
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<td>10.0</td>
<td>71.0</td>
<td>67.0</td>
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<td>1994</td>
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<td>23.0</td>
<td>10.0</td>
<td>70.0</td>
<td>67.0</td>
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<td>1995</td>
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<td>10.0</td>
<td>68.0</td>
<td>67.0</td>
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<tr>
<td>1996</td>
<td>327,460,000</td>
<td>28.0</td>
<td>10.0</td>
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<td>67.0</td>
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<td>1997</td>
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<td>7.5</td>
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<td>1999</td>
<td>382,594,000</td>
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<td>60.0</td>
<td>67.0</td>
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<tr>
<td>2000</td>
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<td>32.0</td>
<td>7.0</td>
<td>61.0</td>
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<tr>
<td>2002</td>
<td>–</td>
<td>369,381,411</td>
<td>26.7</td>
<td>66.0</td>
<td>66.6</td>
</tr>
<tr>
<td>2004</td>
<td>–</td>
<td>387,855,461</td>
<td>28.5</td>
<td>64.1</td>
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<td>2006</td>
<td>–</td>
<td>413,014,732</td>
<td>28.6</td>
<td>64.5</td>
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<tr>
<td>2008</td>
<td>–</td>
<td>389,488,026</td>
<td>24.1</td>
<td>68.3</td>
<td>68.3</td>
</tr>
</tbody>
</table>

Fig. 16 Biological's annual "State of Garbage in America" study shows that the landfill use has decreased from 84% to 66% since 1989. However, overall waste generation has increased (van Haaren, Themeli, & Golstein, 2010).

Fig. 17 USCC map shows states which enacted yard waste bans 1986-1995 (Oshins, 2008).

Fig. 18 Schematic of Life Cycle Assessment (LCA) as calculated with MEBCalc (MADeP, 2006).
### Pounds of Emissions (Reduction)/Increase Per Ton – Summary *

<table>
<thead>
<tr>
<th>Management Method *</th>
<th>Climate Change (eCO₂)</th>
<th>Human Health - Particulates (ePM2.5)</th>
<th>Human Health - Toxics (eToluene)</th>
<th>Human Health - Carcinogens (eBenzene)</th>
<th>Eutrophication (eN)</th>
<th>Acidification (eSO₂)</th>
<th>Ecosystem Toxicity (e2,4-D)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recycle/ Compost</td>
<td>(3620)</td>
<td>(4.78)</td>
<td>(1587)</td>
<td>(0.7603)</td>
<td>(1.51)</td>
<td>(15.86)</td>
<td>(3.48)</td>
</tr>
<tr>
<td>Landfill</td>
<td>(504)</td>
<td>2.82</td>
<td>275</td>
<td>0.0019</td>
<td>0.10</td>
<td>2.38</td>
<td>0.21</td>
</tr>
<tr>
<td>WTE Incineration</td>
<td>(143)</td>
<td>(0.39)</td>
<td>68</td>
<td>0.0019</td>
<td>(0.01)</td>
<td>0.04</td>
<td>0.29</td>
</tr>
<tr>
<td>Gasification/ Pyrolysis</td>
<td>(204)</td>
<td>(0.36)</td>
<td>(1)</td>
<td>(0.0000)</td>
<td>(0.05)</td>
<td>(0.93)</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Fig. 19: MEBCalc LCA data compares waste disposal methods by seven categories (MADEP, 2008).

### Waste Disposal Analysis for Niagara, Ontario

<table>
<thead>
<tr>
<th>Composting (LWY&amp;B and Food waste)</th>
<th>Landfill - LKG Flaring</th>
<th>Landfill LKG - electricity generation</th>
<th>EFW - low estimate</th>
<th>EFW - High estimate</th>
<th>EFW - best case estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net True Cost</strong></td>
<td>$ 927,746</td>
<td>$ 3,545,130</td>
<td>$ 2,329,162</td>
<td>$ 3,614,527</td>
<td>$ 6,733,275</td>
</tr>
<tr>
<td><strong>True cost per tonne</strong></td>
<td>$ 19.66</td>
<td>$ 75.14</td>
<td>$ 49.37</td>
<td>$ 76.72</td>
<td>$ 142.72</td>
</tr>
</tbody>
</table>

Note: The costs associated with organics (leaf/yard/brush and food waste) were aggregated and divided by the amount of tonnes in order to present one “true cost” for composting.

Fig. 20: Waste disposal analysis for Niagara, Ontario compares the true cost of composting, landfill, and incineration/EFW. It is based on MEBCalc model and includes costs of avoided pollutants (CM Consulting, 2007).

### Existing Waste Management Systems

Fig. 21: Landfill disposal dominates international market (Weitz, 2009).
LITERATURE REVIEW: SUMMARY

The internet is filled with composting sites, resources, articles and research; however, these four organizations require particular mention for their long-term contributions:

- **BioCycle** is the leading trade magazine devoted to composting and sustainability. Since 1960, it has provided information on farm, municipal, and industrial composting. It covers operations, equipment, marketing, and economics. However, articles are copyright and only members can access articles.

- **US Composting Council (USCC)** is the industry standard. It works to expand compost markets and enlist public support. The vision statement of USCC is that composting is required to achieve healthy soils, clean water and a sustainable society.

- **Cornell Waste Management Institute (CWMI)** is a branch of Cornell University. CWMI serves the public through research, outreach, training, and technical assistance, with issues pertaining to organic residuals and composting.

- **Environmental Protection Agency (EPA)**
APPENDIX:
SITE MAP AND SAMPLE WEB PAGES

- **Homepage:** [WWW.COMPOSTACTIVIST.COM](http://WWW.COMPOSTACTIVIST.COM)
- **Be an expert**
  - **Learn the biology of compost**
    - Balance air/water
    - Balance nitrogen/carbon
    - Maintain optimal temperature
  - **Learn to collect and process**
    - Methods
    - Troubleshooting
    - Curing
  - **Learn the scientific benefits of compost**
  - **Additional resources**
- **Be an activist**
  - **Help a business**
    - EPA tools
    - Checklist
    - Restricted materials
  - **Help a school**
    - Elementary schools
    - High schools
    - Colleges and universities
  - **Help change policy**
    - Methane gas subsidies
    - Yard waste ban
    - Life cycle assessments
    - Persistent chemicals
- **Be an entrepreneur**
  - Processors needed
  - Haulers needed
  - Event coordinators needed
- **Join the compost community**
WELCOME TO
A WORLD OF COMPOSTING

Composting is not just for gardeners. It is a climate change reduction strategy.

Americans generate more waste than any other nation. In 2006, the US produced 24 million tons of food waste and another 14 million tons of yard waste. Organic waste is compostable. In a natural setting, the aerobic process of decay releases sequestered nutrients back into the earth. However, most modern waste is processed in an airless landfill. Food scraps, yard waste, and paper products cannot decompose without oxygen, and the anaerobic decay from buried waste produces a greenhouse gas called methane. Every time a banana peel or cardboard box goes into the landfill, more toxic gases are produced.

Composting is a sustainability strategy that benefits the environment, the economy, and society. However, a cultural shift is needed before communities, schools, and businesses embrace source separation as a way of life. There is already a national movement to support organic agriculture and green infrastructure, yet the status quo of waste management remains unchanged. Activists are needed to make compost second nature.

TOP 10 COMPOSTING GUIDES

1. Keeping It Easy, Austin, TX (easy)
2. Stop Food Waste, EPA.gov (basic)
3. Start Composting Today, Delaware Department of Natural Resources (basic)
4. Composting: A Beginners Guide, Slippery Rock University, Pennsylvania (basic)
5. Compost Food and Yard Waste at Home, Seattle.gov (basic)
6. Canadian Compost Guide, MMSS (basic)
7. Basic Principles of Composting, LSU Ag Center (intermediate)
8. Compcycle Mastery Composter Guide, NCC Composting Project (advanced)
9. A Rind Is a Terrible Thing to Waste, Cornell University (advanced)
10. Urban Composters’ Guide, Urban Garden Center (advanced)

Composting concerns everyone, and it is important to understand how large-scale facilities process tons of organics each day. Communities, schools, and businesses can reduce the effects of climate change by diverting organics from trash. Click and scroll to tour a two million ton composting facility in Delaware (2-minute video).
The freeze/thaw process maximizes the cellular surface area. If you choose not to separate organic materials for composting, it will be buried or burned. If you are unable to compost, consider 1) donating food scraps to a composting friend or community garden or 2) locating a compost facility or hauling services to pickup and transport organic waste to a professional facility.

**Types of Compost Methods**

- Aerated Static Pile
- Tumbler
- Worm Composting
- Banana Composting
- Square Foot Composting
- Shovel Composting
- Leaf Composting
- Root Composting

**Review composting options.** Choose a system easy to operate, with slow decomposition rate, using a tarp system. However, a small scale composting system is still an acceptable method to keep composting out of the landfill.

- **Make your own bin:** This Cornell publication provides instructions to build a composting system. Use chicken manure, cow manure, and horse manure. A simple solution is a bin made of wood or wire mesh. A more complex solution is a tumbler bin made of plastic or metal. The bin should be aerated to increase the oxygen flow.
- **Consider building an aerated static pile:** The most advanced option is a design that incorporates a blower. A small ASP system can reduce the need for mechanical aeration.
- **Composting can be as simple as or as complicated as you want to make it.** Just remember that your role is facilitator; the microbes do the real work. If it has been a while since you have worked at the process of decay, you may want to start with an ASP or make a composting pile.
BE AN EXPERT

EXPERT: LEARN THE BIOLOGY OF COMPOST

Balance Air / Water  Balance Carbon / Nitrogen  Maintain Optimal Temperature

BALANCE CARBON / NITROGEN

- C:N Ratio  Exercise  Play Game

C:N RATIO

Microorganisms do not survive without sufficient carbon; brown materials provide carbohydrates and energy. They will also die without sufficient nitrogen; green materials support reproductive functions. The most efficient carbon-to-nitrogen ratio (C:N ratio) is within the 25:45 range. Experienced composters intuitively balance C:N sources, just as professional cooks intuitively add the proper amount of salt to a meal. Piles with a C:N ratio too high (excess carbon) take longer to decompose; piles with ratios too low (excess nitrogen) create foul odors.

Basic composting instruction advise one part green/nitrogen to two parts brown/carbon; in reality the C:N ratio for every material is unique. For example, the C:N ratio for shredded cardboard is 33:1 and for manure is 7:1. Therefore, if you were only using cardboard and manure it would be necessary to add 9 parts of manure to one part cardboard. Microbial diversity is enhanced by varied materials; therefore, try to use leaves from multiple trees species, shred some cardboard and newspapers, and throw in some pine needles.

- C:N Ratio  Exercise  Play Game

EXERCISE

Use the example to the right and table below to calculate C:N ratios. Healthy compost piles have C:N ratios between 25:45. 1: STEPS: 1.) lookup the C:N ratio of each feedstock in the table below 2.) multiply the ratio of feedstock with each portion 3.) add the columns and divide to get a ratio of C:N. Calculate which of these combinations below are within the acceptable range:

- 1 part hay, 1 part sawdust, 2 parts vegetable scrap
- 1 part cardboard, 1 part horse manure
- 3 part fruit waste, 2 part dried leaves

<table>
<thead>
<tr>
<th>Feedstock 1</th>
<th>Feedstock 2</th>
<th>Feedstock 3</th>
<th>Feedstock 4</th>
<th>Feedstock 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 parts leaves</td>
<td>1 part apple pomace</td>
<td>3 parts fruit waste</td>
<td>1 part horse manure</td>
<td>2 parts cardboard</td>
</tr>
</tbody>
</table>

Determining C:N Ratio for a Given Mixture of Feed Stocks

- 2 parts leaves 2 x (60.1%) = 120.2
- 1 part apple pomace 1 x (48.1%) = 48.1
- 3 parts fruit waste 3 x (18.3%) = 54.9
- 1 part horse manure 1 x (25.8%) = 25.8
- 2 parts cardboard 2 x (16.7%) = 33.4

Result: 120.2:48.1:54.9:25.8:33.4

= 50:1 (too much C)

BE AN EXPERT

LEARN TO COLLECT AND PROCESS

Composting Methods  Troubleshooting  Curing

CAUTION: TROUBLESHOOTING

<table>
<thead>
<tr>
<th>Troubleshooting</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bad Smell</td>
<td>Excess moisture (anaerobic conditions)</td>
<td>Add dry material like woodchips, sawdust or straw</td>
</tr>
<tr>
<td></td>
<td>Compaction</td>
<td>Turn pile or make pile smaller</td>
</tr>
<tr>
<td></td>
<td>Ammonia Odor</td>
<td>Too much nitrogen (lack of carbon)</td>
</tr>
<tr>
<td></td>
<td>Low Pile Temperature</td>
<td>Pile too dry</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Too much carbon (lack of nitrogen)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cold weather</td>
</tr>
<tr>
<td></td>
<td>High Pile Temperature</td>
<td>Pile too large</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of oxygen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pile too small</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Troubleshoot your compost

- Compost too dry
  - In water
  - In tumbling
  - Add water
  - Add more water
  - Compost too cold
  - In tumbling
  - In water
  - Warm compost
  - Add heat
  - Add hot water
  - Smelly compost
  - In tumbling
  - Too much food
  - Reduce food
  - Add more air
  - Add water
  - Compost too wet
  - In water
  - Too much compost
  - Drain compost
  - Add more compost
  - Add water
  - Ozing gunk
  - In water
  - Too much compost
  - Warm compost
  - Add hot water
  - Small flake flies
  - In water
  - Warm compost
  - Add more compost
  - Add water
  - Large blow flies
  - In water
  - Warm compost
  - Add more compost
  - Add water
**BE AN EXPERT**

**EXPERT: LEARN THE SCIENTIFIC BENEFITS OF COMPOST**

*A nation that destroys its soil, destroys itself.*

- Franklin D. Roosevelt to governors urging soil conservation laws.

1. Composting **reduces GHG emissions**.
2. Composting **reduces water**.
3. Composting **mitigate climate change**.
4. The use of finished compost **improves water quality**.
5. The use of finished compost **increases soil water holding capacity**.
6. The use of finished compost **increases plant disease resistance**.
7. The use of finished compost **improves soil compaction**.
8. The use of finished compost **prevents erosion near creeks, lakes, and rivers**.
9. The use of finished compost **reduces pollution**.
10. The use of finished compost **improves public health**.

Compost is the best medicine for disturbed soil; it helps sandy soils retain water and helps clay soil breathe. The recycled ingredients of compost not at differing rates and provide a slow-release of nitrogen, phosphorus, potassium and other microelements. This is especially important for soil that has suffered the effects from pesticides, herbicides, blasting, drilling, heavy equipment and layers of imperious surface. Mature compost is not a soil, a synthetic fertilizer, mulch or manure. It is a complex organic material that cannot be replicated in a lab or replaced by chemical fertilizers; scientists have yet to determine its recipe and structure. It is an elixir that reduces effects of drought; sequesters carbon; assists pollution cleanup; prevents erosion; buffers pH; increases cation exchange; and reduces need for pesticides. Disturbed soil is unable to perform those soil functions.

Read the articles linked above to understand the details how composting improves agriculture, water retention, atmospheric stability and public health. National composting could improve four of Obama's sustainability goals: reduce overall waste, reduce green house gas emissions, improve air quality and public health. Yet many of the state sustainability plans to meet federal guideline ES 2014 do not include large scale composting. It imperative that citizens be encouraged to separate their waste.

Policy and culture must converge on this topic to protect the soil, the earth and humanity itself.

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**BE AN ACTIVIST**

**ACTIVIST: HELP A BUSINESS**

**EPAs Calculators** | **Composting - Checklist** | **Concerns**

Because A Rind Is A Terrible Thing To Waste

*is a 30-minute video produced by Cornell University to help businesses divert organisms.*

Every food waste generator shares partial responsibility for the liabilities of landflling organic waste. To help businesses reduce their carbon footprint, the EPA developed the Sustainable Materials Management Program and designed a Food Recovery Challenge to help commercial businesses realize the benefits of separating organic waste from trash. Already ShopRite Supermarkets and Four Seasons Hotels have progressed through the program. Click here to access the EPA’s WasteWise toolkit and learn more about the Food Waste Calculator and the Waste Reduction Model (WARM) Calculator.

Encourage waste generators to perform a waste audit. Help them access EPA’s free Food Waste Calculator and give them a copy of the checklist. Explain the environmental, social and financial rewards for diverting organics to compost. Share these videos and articles below with managers of restaurants, grocery stores and food waste generators.

**ARTICLES AND GUIDES:**
**BE AN ACTIVIST**

**ACTIVIST: HELP A BUSINESS**

**EPA's Calculators**  Composting - Checklist  Restricted Materials

**EPA Food Waste Calculator**  EPA WARM Calculator  EPA GHG Equivalency Calculator

**USE EPA FOOD WASTE CALCULATOR**

The first step to commercial composting is to perform a waste audit. The EPA Food Waste Calculator tool guides managers through the process of quantifying food waste to determine if composting is a cost-effective solution. The Food Waste Management Calculator is specifically designed to help food-service professionals learn about and evaluate alternative diversion methods. Any user can access the free online tool to determine if composting is a cost-effective solution. The calculations are based on user inputs and an extensive body of research regarding life-cycles of organic waste; the output is a professional Excel workbook which includes a cost data analysis, a cost graph, benefits, recommendations and a summary. A user can input data for different scenarios to compare cost projections. The input screen looks like this (Fig. 1) but the complete, online workbook is available here: Food Waste Management Calculator.

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**BE AN ACTIVIST**

**ACTIVIST: HELP A BUSINESS**

**EPA's Calculators**  Composting - Checklist  Restricted Materials

**RE stricted Materials**

It is important for a commercial facility to check with the composting facility for a list of restricted materials it is legally permitted to process:

- Category 1: pre-consumer plant waste
- Category 2: animal derived waste
- Category 3: animal and post-consumer food waste with pathogen potential
- Category 4: other wastes, never sludge

State regulators distinguish between pre-consumer food (vegetative trim waste generated during meal preparation) and post-consumer food (plate waste from unserved food could have human genes). This distinction is not readily apparent to new composters and activists who want to increase composting practice are outraged by the barrier and sometimes try to ignore the rule. Asking people to separate waste is a burden, but asking people to separate pre-consumer waste from and post-consumer waste is an unwinnable fight. Each composting facility may have a different set of restricted materials it is legally permitted to process. These facilities which do not accept post-consumer waste do not accept meat or dairy either. However, even facilities that accept all materials in category 3 requires a clean collection without plastic film, straws, beverage lids, condiment packets, labeling tags mixed with the food waste.
BE AN ACTIVIST

Help A Business | Help A School | Help Change The System

ACTIVIST: HELP A SCHOOL

Elementary Schools | High Schools | Colleges and Universities

Schools and institutions generate large volumes of food waste, although they may be willing to divert their waste, they often do not have the time or skills needed to develop a composting program. The Northeast Recycling Council (NERC) is a non-profit organization which has successfully supported schools develop composting programs. Compost activist are needed to bring these materials to local schools. Composting is an excellent hands-on learning tool to teach children about biology, math and the environment.

Use these embedded links to find valuable resources specifically designed to help schools understand why and how to compost. Additional resources are available for elementary schools, high schools and colleges.

- Review NERC's newsletter for school composting.
- View and share NERC's PowerPoint presentation describing the process of starting a school composting program.
- Form a composting team. Include members from administration, custodial staff, teachers and students.
- Conduct a waste assessment to estimate the volume of school waste. Set up three bins in the cafeteria labeled "compostable", "recyclable" and "trash (plastic, metal and dairy)" and instruct kids to separate waste.
- If you are ambitious, use the EPA Food Waste Calculator guidelines.
- Review the results of the waste audit and determine what method of composting is most appropriate.
- If on-site composting is appropriate, contact your state environmental agency to discuss permit requirements. Then review these options:
  1. apply for an EPA environmental education grant.
  2. build a filter.
  3. build a composting system.
  4. purchase an incinerated composting system.
- If off-site composting is appropriate, contact a hauler to transport separated organic materials to a permitted facility.
- Visit other institutional composting operations in network with others schools that have a composting program or want to start a composting program.
- Consider purchasing disposable trash bins to reduce the need to sterile collection bins; consider purchasing compostable plates and cups for cafeteria use to reduce collection contamination.

Many schools realize an overall cost savings by diverting organic waste; formulate a budget using tools above. Start with a small pilot program that incorporates waste of food waste, and expand the program in phases. Be vigilant with onsite composting; an abandoned pile can create a health hazard. Use the finished compost in a school garden. Enjoy!

BE AN ACTIVIST

Help A Business | Help A School | Help Change The System

ACTIVIST: HELP A SCHOOL

Elementary Schools | High Schools | Colleges and Universities

Elementary Schools

Kids have a natural curiosity about bugs and the environment; they enjoy learning about compost. Below are age appropriate resources to expose elementary school children to composting. ENJOY!!

CASE STUDIES, ELEMENTARY SCHOOL COMPOSTING:

1. Davis School District, California
2. Friend Central School, New York
3. Jackson Elementary, Massachusetts
4. Milton Academy School, Massachusetts
5. Ring School, Massachusetts

CASE STUDIES | Guides | Videos | Games | Activities | Books

COMPOSTING GUIDES:

1. "Keeping It Easy," colorful 9-page guide for very young kids published by Austin, TX
2. "Composting in the Community," colorful 9-page guide to promote composting
3. "Growing Wild," a 10-page guide for older children that introduces the microorganisms
4. "Break It Down," 6-page guide for junior high school students learning about the carbon cycle
5. "Composting Resources," for Schools
6. "Free Poster," published by the Canadian Composting Society
BE AN ACTIVIST

ACTIVIST: HELP CHANGE THE SYSTEM


Landfilling waste produces large quantities of toxic methane gas and it depletes soil from nutrients; composting is a greenhouse gas reduction strategy and returns nutrients to the soil. Composting is the waste management solution endorsed by the EPA because life cycle assessment tools prove that it is more sustainable than landfill or incineration.

Although it seems that policy and culture are converging on the issue of composting, four political issues may keep landfill as the dominate waste management solution for decades to come. Read further to learn about controversial issues and how your voice is needed to change current policy. Germany and Denmark have already banned organics from landfill and other countries have implemented voluntary or partial bans. The state of Massachusetts is trying to be the first state in the union to ban pre-consumer food waste from landfill. Yet without an understanding of how:

- EPA classified landfill gas as a renewable energy source
- Lebanon is repealing state laws which ban yard waste from landfills
- Persistent chemicals threaten to contaminate compost
- Carbon sequestration criteria used for Life Cycle Assessment (LCA) tools are controversial
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