Composting Guide For Kansas Communities And Businesses

KANSAS
DON'T SPOIL IT!

Kansas Department of Health and Environment
Gary R. Mitchell, Secretary
March, 1998

PREFACE

This guide was prepared by the Kansas Department of Health and Environment to assist city, county, and regional officials in developing and implementing composting programs to efficiently and effectively manage yard waste. It was designed to comprehensively address every aspect of composting including planning, design, construction, operation, marketing of produced material, and even trouble-shooting. The guide consolidates much of the best available information prepared by many of the nation's best experts.

Communities and private companies interested in starting new composting facilities can use this guide to plan and implement programs which are well suited to their unique circumstances. Existing program managers can use the guide to enhance operations and maintain successful operating conditions.

This guide provides information on the proposed administrative regulations which cover the composting of yard waste, source separated waste, and municipal solid waste. These regulations also address land application of yard waste. Adherence to the recommended guidelines presented in this document will help ensure that facilities are designed, constructed, and operated in accordance with all applicable Kansas laws and regulations.

Worksheets are provided in this guide to assist local planners or waste management officials in implementing new or enhanced facilities based upon site specific economic and technical factors. However, this guide is not intended to be the only information resource for establishing and operating central site composting programs. Local governments and private companies are encouraged to consult with the Department of Health and Environment and other experts in the field to receive additional assistance.

The Department of Health and Environment encourages every Kansas community to consider implementing a central composting program to minimize the amount of waste which must be locally landfilled or transferred for disposal in another county. Tremendous progress has been made in Kansas over the past four years to implement composting programs even though yard waste may be landfilled under state law. Local officials have come to understand the short- and long-term benefits of reducing the amount of waste which is landfilled. Hopefully, this voluntary trend to increase waste recycling and composting will continue.

ACKNOWLEDGEMENTS

This guide is based on a collection of technical and operational methods gathered from existing composting manuals around the nation.

Special thanks is extended to the Iowa Department of Natural Resources for allowing their composting manual to be modified to meet the needs of facility operators in Kansas.

The following organizations and people should also be recognized for developing much of the technical information in the manual and for allowing their work to be utilized or reprinted as needed:

- Leaf and Yard Waste Composting Manual, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, MA.
- Muncipal Yard Waste Composting, A Handbook for Wisconsin Communities, Dane County Department of Public Works, July 1988.
- Leaf Composting Manual for New Jersey Municipalities, Department of Environmental Protection, Division of Solid Waste Management, Office of Recycling and Rutgers State University, May 1989.
- Leaf Composting, A Guide for Municipalities, The State of Connecticut Department of Environmental Protection, Local Assistance and Program Coordination Unit, Recycling Program, Prepared by the University of Connecticut Cooperative Extension Service, January 1989.
- Yard Waste Composting Guide, Michigan Department of Natural Resources, Resource Recovery Section, Waste Management Division, Written by Jim McNelly of RECOMP, Inc., prepared and compiled by Flowerfield Enterprises.
- Compost Operations Manual, Minnesota Pollution Control Agency, Groundwater and Solid Waste Division, St. Paul, MN, May 1989.
- Municipal Scale Leaf and Yard Waste Composting, Fredric A. Waldstein, Ph.D., Wartburg College, Waverly, IA. Program materials and technical support provided by Wartburg College, Waverly, IA, Bentley College, Waltham, MA and Massachusetts Department of Environmental Protection, Boston.
- Landscape Waste Compost, Distribution and Marketing Strategies for Centralized Municipal Composting Operations, Illinois Department of Energy and Natural Resources, Office of Solid Waste and Renewable Resources, Springfield, IL, March 1989.
- Decision-Makers Guide To Solid Waste Management, EPA/530-SW-89-072, U.S. Environmental Protection Agency, Solid Waste Emergency and Response, November 1989.
- Considerations for Direct Land Application of Organic Waste Products, Kansas State University, Cooperative Extension Bullentin,1997.
- Guide for Community Yard Waste Composting in Kansas, Kansas State University, Cooperative Extension Bullentin,1997.
- Recycling Yard Trash: Best Management Practices Manual for Florida, Florida Organics Recyclers Association in conjunction with the Florida Center for Solid and Hazardous Waste Management, 1996.

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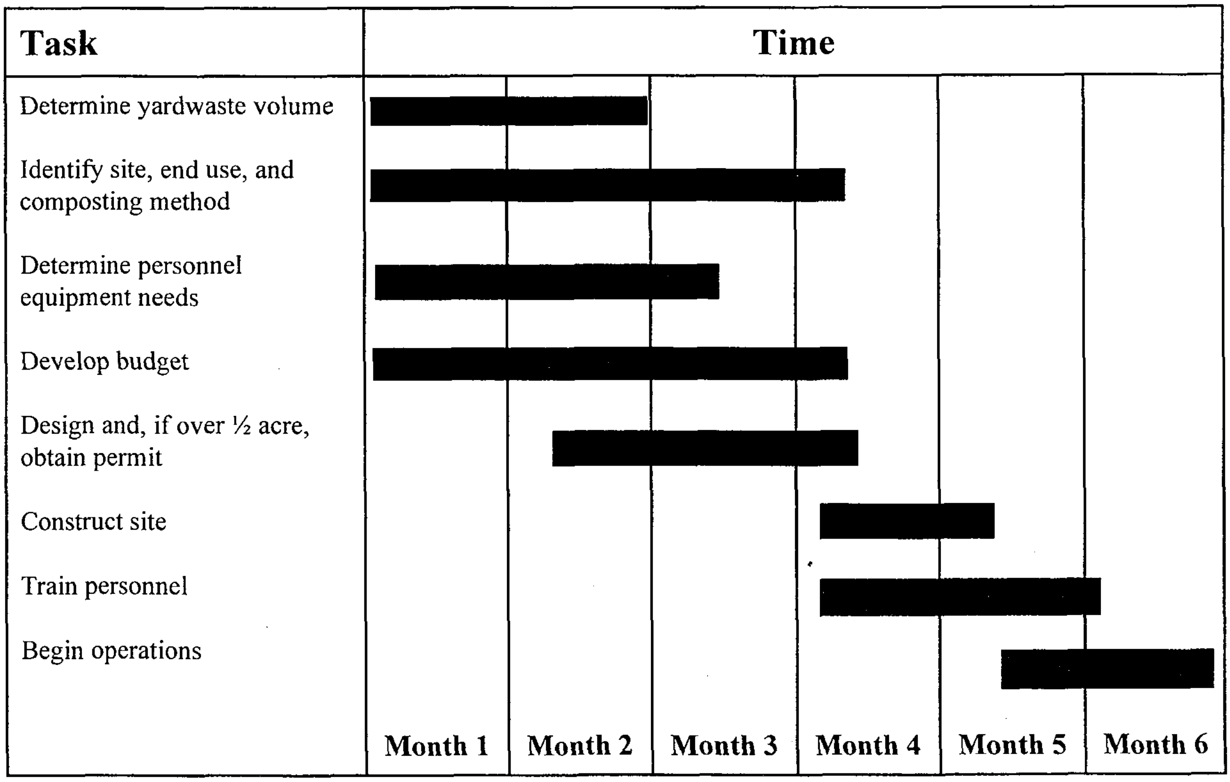
Chapter 1: Introduction - An Overview of Planning

Notes

The desire to save landfill space, conserve resources, and save on the community's disposal costs are making composting of yard waste an attractive alternative to disposal for many Kansas communities. Composting can be a low-effort, cost-effective and environmentally sound method to manage a community's yard waste. Composting conserves landfill space, reduces disposal costs and produces a useful end product. But, the process of composting is not only one of piling leaves for decomposition. Rather, it is a controlled process requiring advanced planning. Several key decision areas regarding yard waste collection, processing and compost end use will be addressed in this guide. The following table summarizes the projected time schedule needed for implementing yard waste composting projects.

Projected Time Line For Starting A Compost Site



Time periods in this chart are estimated based on yard waste composting sites. MSW and source separated waste composting sites may require longer times. If information on permit application is incomplete, the time required to obtain a permit can be greatly extended.

Notes

1.1 Determining the Volume of Yard Waste

Estimating the volume of yard waste is necessary to determine the size and type of operation as well as to compute the amount of finished compost that may be available.

One way to measure yard waste volumes is to monitor the spring and fall collection periods by measuring truck loads collected. In a 1988 U.S. Environmental Protection Agency report by Franklin Associates, yard waste composed 18% (by weight) of the annual municipal solid waste stream. However, this percentage can increase to 25 to 40 percent of the waste stream in the fall and spring. Further information regarding volume of yard waste can be found in Section 4.1.

Estimated Kansas Municipal Solid Waste

Waste Category	**Generated in 1995**		**Recovered in 1995**	
	(Tons per year)	**% of Total Generation**	**(Tons per year)**	**% of Category Generation**
Newspapers (ONP)	114,240	5.92	28,680	25.1
Corrugated Containers (OCC)	240,070	12.43	107,880	44.9
Office papers	87,870	4.55	6,870	7.8
Magazines	32,920	1.70	5,600	17.0
Mixed Paper	197,760	10.24	2,070	1.0
HDPE & PET	12,020	0.62	1,220	10.1
Other plastics	106,660	5.52	100	0.1
Aluminum cans	18,590	0.96	7,470	40.2
Other aluminum packaging	3,620	0.19	0	0.0
Steel cans	31,810	1.65	1,820	5.7
Other steel packaging	1,710	0.09	0	0.0
Major appliances	28,050	1.45	13,690	48.8
Glass containers	83,430	4.32	7,830	9.4
Textiles	43,040	2.23	20	0.0
Yard trimmings	227,170	11.76	17,970	7.9
Food waste	173,250	8.97	0	0.0
Lead Acid batteries	15,060	0.78	14,740	97.9
Wood packaging	57,250	2.96	710	1.2
Other durable goods	246,700	12.78	230	0.1
Other misc. organics	181,670	9.41	0	0.0
Other misc. inorganics	28,210	1.46	0	0.0
Totals	**1,931,100**	**100.00**	**216,900**	**11.2**

1.2 Yard Waste Collection

Notes

Yard waste collection involves both municipal collection and independent hauling by residents, groundskeepers and private haulers. There are three basic methods of collecting yard waste for composting:

1. a drop off system at the local landfill, transfer station, or composting facility;

2. curbside collection in bags, or;

3. bulk collection in which yard waste is scooped, raked, swept or vacuumed directly off of the streets. A detailed discussion of municipal yard waste collection can be found in Section 4.2.

1.3 End Users for Compost

Decisions regarding the end use of compost determines the composting method and the equipment to be employed. Yard waste compost is valuable as a mulch, soil amendment and topsoil substitute. Generally, the higher the quality of the compost, the easier it will be to find end users. Intown applicators, such as parks, public works departments, residents' lawns and flower gardens will minimize the need for "marketing."

Higher quality compost requires additional steps for processing and screening. A detailed discussion of compost end use and marketing will be included in Chapter 11.

1.4 Site Selection

Choosing an appropriate site for a composting facility requires consideration of the following criteria:

- The size of the site is determined by the volume of yard waste (especially leaves) collected. Approximately 6,000 cubic yards of yard waste per year can be composted on one acre of land.

- A central, accessible location with good traffic flow.

- Easy entry and exit for yard waste deliveries.

- Adequate buffer area to protect neighbors from the impact of site activities.

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- A location where prevailing winds blow away from sensitive neighbors.

- A low water table (to prevent groundwater contamination)

- A location within adequate distance from wetlands and flood plains.

- A high soil percolation rate, but not excessively permeable soils, so to avoid standing water.

- A nearly level surface (one to three percent grade).

- A means of securing the site from illegal dumping.

- Other site alterations to support machinery during the four seasons of the year may involve regrading the surface (also allowing for proper drainage). Site alterations should be done by September allowing materials to be composted to be received by early October.

Additional information regarding siting and site plans can be found in Chapter 5.

1.5 Composting Methods

Determine a compost processing method appropriate to a municipality's or service area's needs by considering the following factors:

1. site constraints and distance to neighbors;

2. material(s) being composted; and

3. the costs associated with the composting operation. The following paragraphs describe various levels of composting technology. Details regarding these compost methodologies are discussed in Chapter 3.

- **Windrowing** requires yard waste to be placed in individual rows, triangular in cross-sections, the length exceeding height and width, and turned frequently. Special windrow turning equipment may limit the height of the piles. This method generally takes eight to twelve months to achieve a final product.

- **Aerated static pile** composting requires that the composting mixture be placed in piles that are mechanically aerated. The aerated static piles are turned only when the composting process is nearly complete. Odor traps or filters can be used to control odor migration, although odor from the piles is generally minimal.

  The aerated static pile is usually less-capital intensive then either an in-vessel system or windrow system. However, there may be continued electrical costs to operate the air supply to the compost piles.

  The composting time required for aerated static pile technology ranges from six to twelve weeks. The land requirements for this method are lower than those of a windrow method of composting.

- **In-vessel composting** involves placing the composting mixture in a chamber or vessel where mixing, aeration and moisture control are provided. There are several in-vessel systems available, some requiring minimal preprocessing of Municipal Solid Waste (MSW); others requiring extensive preprocessing.

  The major advantage of the in-vessel system is that all environmental conditions can be carefully monitored, allowing for rapid composting. In-vessel systems offer short retention time, often only one to two weeks. The vessels are generally placed in a building, and if properly operated, produce minimal odors and no leachate.

- **Co-composting** is the composting of two or more wastes with different characteristics. For example, composting liquid/dewatered sewage sludge with MSW is co-composting, as is composting anything in addition to yard waste. KDHE rules for composting only yard waste are different from co-composting two types of waste.

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1.6 Equipment

The equipment necessary for processing compost range from simple to complex and specialized.

A specialized piece of equipment is a windrow turner which combines the moving and mixing of the compost material. This piece of machinery is capital intensive, but may be ideal for the municipality mixing waste streams or incorporating large amounts of grass to the compost. A windrow turner also enhances degradation by continually reducing and mixing materials.

Notes

A tub grinder may be used to reduce and shred yard waste. By reducing the size of the yard waste particle, the surface area of the particle increases, thus allowing more biological activity by decomposing organisms, decreasing degradation time.

A relatively inexpensive, yet essential item is a three-foot stem, 0 to 200°F thermometer. With proper training, use of this thermometer allows the site operator to monitor windrow temperatures and determine the appropriate time to turn the material. It also indicates when the material is composted and ready to move off-site before the next planned collection begins. A list of thermometer suppliers is included in Appendix C.

Screening or shredding of the finished compost improves the quality of the end product. Screens and shredders are available in a number of sizes and variations and may be stationary or trailer-mounted.

Since composting is a seasonal operation, it is possible to save money by using existing public works, highway, or sanitary department equipment such as trucks, front-end loaders, shredders, choppers, and some farm equipment. If the community is small, consider teaming up with neighboring communities and share equipment and sites.

Review the planning process carefully when discussing equipment purchases as processing and monitoring equipment can take two to three months to order and receive. A list of processing equipment approximate costs and operation specifications can be found in Appendix D-1. For an in-depth discussion on processing equipment, refer to Appendix D-2.

1.7 Staffing

Determining the personnel needed for the composting operation depends upon the level of technology selected. Generally, a minimum of two workers are required to monitor yard waste deliveries, supervise operations at the composting site, and maintain records. Additional personnel may be needed to collect and transport yard waste to the site. There should be backup personnel for each job. The majority of the hours will be seasonal - spring and fall; however, piles may be monitored daily or weekly, and turned accordingly to weather conditions and temperature trends within the piles.

1.8 Program Management

A municipality may not have the staff or equipment to conduct its own operation, but yard wastes still need to be diverted from landfill disposal. A municipality has a number of options for managing a compost operation.

These management options can also be applied on a regional basis with one community supplying a site, and others providing equipment and staff, either continuously or on a rotating schedule.

Notes

1.9 Public Education

A community composting program will be more successful if it is implemented with a well organized public education campaign. Participant understanding and cooperation is essential since citizens are the generators of a significant portion of the yard waste. Focusing on the 5-W's: who, what, where, when, why, in addition to how--will encourage the necessary participation of a successful composting project. The details of public education are addressed in Section 4.3.

1.10 Permits

A composting permit is required for those facilities larger than ½ acre as defined by K.S.A. 65-3401(y). Facilities under ½ acre will be required to meet performance standards to be described in regulation. (See Appendix I for proposed regulation.) Also, a permit is required for the land application of any solid waste other than yard waste. For further information regarding composting permit requirements contact: Kansas Department of Health and Environment, Bureau of Waste Management, Bldg. 740, Forbes Field, Topeka, KS 66620-0001 or telephone: (785) 296-1600. (See Appendix M for current yard waste compost permit list.)

1.11 Costs

Records showing the economic benefits of composting will assist a community in justifying the renewed costs on the following year's budget. Benefits may be expressed in the form of avoided "tipping fees," the volume of landfill space conserved, avoided transportation costs, money saved by not purchasing soil, or any actual revenues received if the compost is sold. Monetary factors are not the only benefits of composting. Land conservation and revitalization of soils are other benefits which may not be quantifiable. Chapter 12 includes the economic potentials of yard waste composting.

Notes

Chapter 2: Composting Basics

Notes

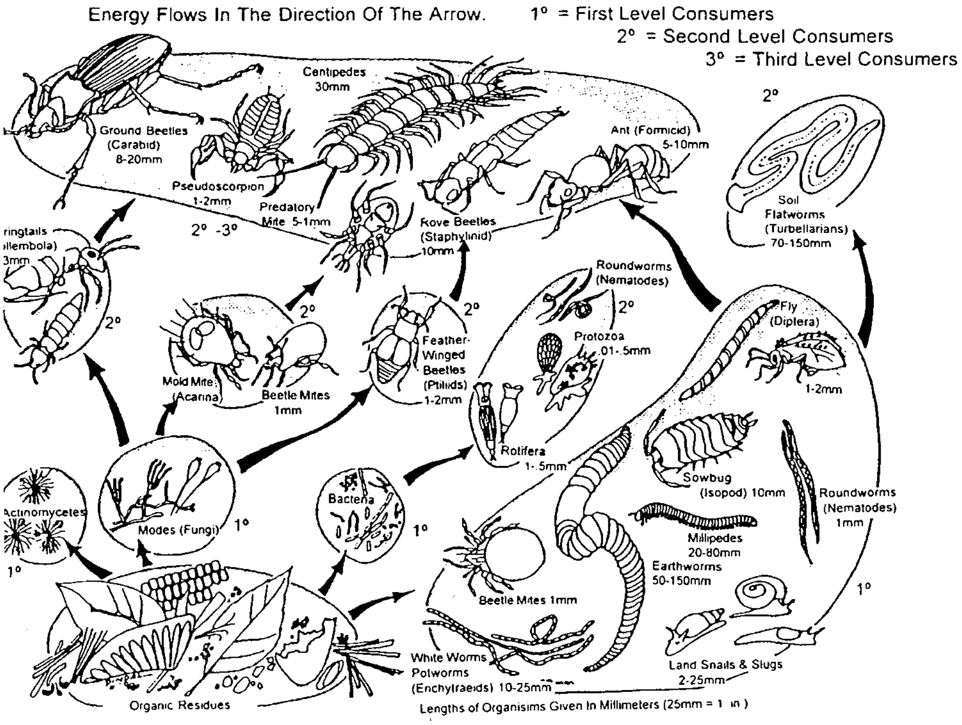
2.1 Fundamentals of Composting

There are seven factors to consider in order to effectively manage a compost pile and maintain optimal efficiency of the microbial activity:

2.1.1 Microorganisms

Microorganisms found on the surfaces of leaves, grass clippings, and other incoming organic matter are fully capable of starting and sustaining the composting process. This eliminates the need to purchase commercially available inoculants, thus reducing costs. Shown below is the microbial community which aids in the composting of yard waste.

Food Web of The Compost Pile



(Source: Dr. Daniel Dindal, cited in Michigan Department of Natural Resources (1989). Yard Waste Composting Guide)

Notes

2.1.2 Moisture

Adequate moisture in the compost pile is necessary in order to support microbial activity and growth. Moisture levels of between 40-60% are recommended and should be maintained. Inadequate moisture will slow down the composting process. Excessive moisture (greater than 60%) will inhibit oxygen penetration into the pile, increasing the risk of inducing odor-causing anaerobic (without oxygen) decomposition.

At most sites the squeeze test can be used to determine the moisture content of the pile. In this method, if squeezing a handful of material results in the release of only a few drops of water, the moisture is just about right. Unless the material feels quite damp, the moisture level is probably too low.

Incoming leaves may have a moisture level of only 30-40%, while grass clippings generally have moisture levels of 60-70%.

2.1.3 Oxygen

Adequate oxygen penetration into compost piles is necessary to assure the aerobic (requiring oxygen) decomposition of the yard wastes. Oxygen levels between 5 and 15% are recommended. Otherwise anaerobic conditions may occur thus slowing decomposition, producing foul odors, and lowering pH levels (i.e., too acidic). In order to maintain adequate oxygen levels, care must be taken to minimize compaction of the yard waste, avoid excess moisture levels, and to turn the piles frequently to allowing the center of the pile to reoxygenate.

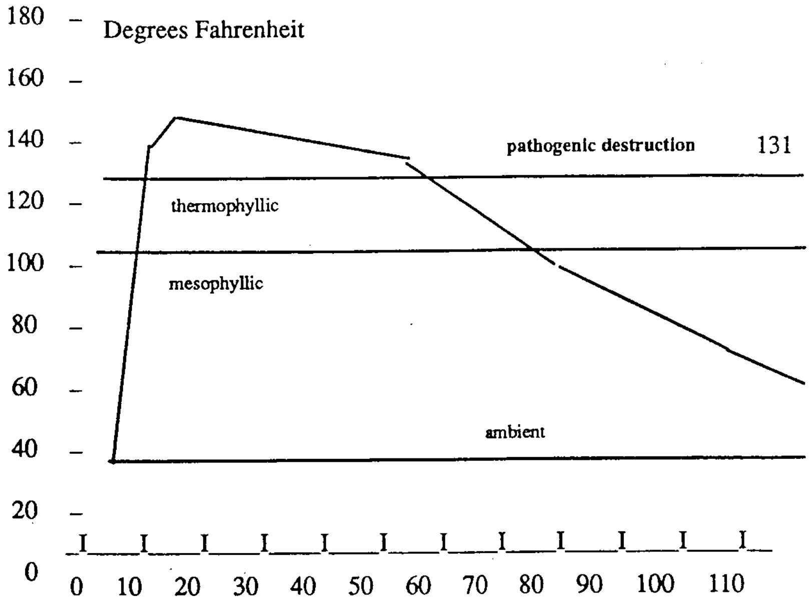
2.1.4 Temperature

Internal compost pile temperatures affect the rate of decomposition as well as the destruction of plant pathogens and weed seeds. Properly decomposing wastes will experience a significant temperature rise at first followed by a gradual temperature decrease until decomposition is nearly complete. Temperature should be monitored on a regular basis and controlled by turning the pile which as previously mentioned, will also oxygenate the center of the pile. Temperatures in the range of 68° F to 140° F are common.

(See illustration on following page.)

GENERIC GRAPHIC REPRESENTATIVE OF TEMPERATURE CHANGES WITHIN WINDROWS

Notes

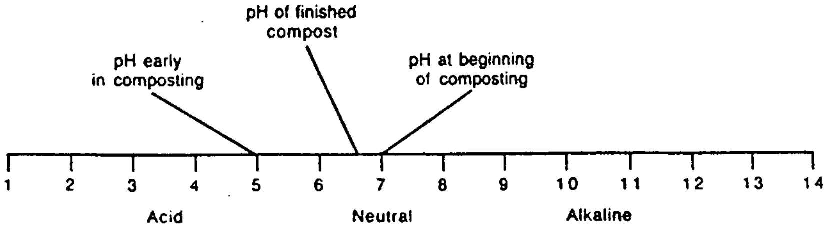


(*Source: Michigan DNR, 1989*)

2.1.5 pH

A measure of the degree of acidity or alkalinity of a material, is the pH value. A pH of 7 being neutral, less than 7 acid, greater than 7, alkaline. Yard wastes generally are close to being chemically neutral. During the initial stages of normal decomposition, the production of organic acids causes the pH to decline to levels as low as 4.2 if extensive anaerobic conditions develop. The pH will recover to a neutral range (6 to 8) as the acids decompose in the presence of oxygen. Persistently acidic pH is indicative of undesirable, prolonged anaerobic decomposition. This can be corrected by increased turning (oxygenation) of the pile. Adding neutralizing agents, such as lime, is not recommended for most facilities.

THE pH SCALE



pH Scale

(*Source: Michigan DNR, 1989*)

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2.1.6 Carbon/Nitrogen Ratio (C:N)

Some understanding of the concept of the carbon to nitrogen (C:N) ratio is necessary to manage a compost operation. Carbon and nitrogen are the primary elements that organisms need for food. Bacteria and fungi get their energy from carbon found in carbohydrates, such as the cellulose in grass or leaves. Nitrogen, a component of protein, is necessary for the population growth of decomposing microorganisms.

The availability of nutrients in the organic material is a limiting factor in the composting process. Accelerated decomposition requires a proper balance of these macro nutrients. If the carbon/nitrogen ratio is too far out of balance, the microbial system will suffer.

The carbon to nitrogen ratio in leaves tends to range between 60:1 and 80:1. Thus composting of this material can range from six months to three years, depending on the composting method used. With the proper addition of grass and other nitrogen-rich materials, the carbon-nitrogen ratio will approach the optimum range of 25:1, and the composting processing is accelerated.

The optimum range of the carbon-nitrogen ratio is from 20:1 to 30:1. The more the carbon-nitrogen ratio deviates from this range, the slower the decomposition process becomes. With a ratio of greater than 40:1, nitrogen represents a limiting factor and the reaction rate slows. With a carbon-nitrogen ratio lower than 15:1, excess nitrogen is driven off as ammonia. While this loss of nitrogen is not detrimental to the process of decomposition, it lowers the nutrient value of the end product and can contribute to odors generating from a compost site. The following C:N tables can be used to estimate the quantity of various feedbacks needed to obtain an optimum C:N ratio.

Material	**C:N ratio**	**Material**	**C:N ratio**
Grass Clippings	19:1	Digested Sewage Sludge	16:1
Food Wastes	15:1	Activated Sewage Sludge	6:1
Cattle Manure	19:1	Laying Hen Manure	6:1
Tree Leaves (dry)	54:1	Wood Chips/Sawdust	300-700:1
Newsprint	398-852:1	Telephone Books	772:1
Waste Paper From Refuse	170:1	Corrugated Cardboard	563:1
Hay (legume)	16:1	Hay (grass)	32:1
Straw (wheat)	127:1	Corn Silage	40:1
Slaughterhouse Waste	4:1	Paunch Manure	25:1

(Adapted from: On-Farm Composting Handbook and other sources.)

2.1.7 Pile Size and Turning Frequency

Notes

Compost pile temperature and oxygen content can be regulated to some extent through pile size and turning operations. Larger piles conserve heat, but if the piles are too large, temperatures may become excessively high and cause anaerobic conditions to occur. Yard waste windrows should be turned at least once every two weeks, or whenever pile temperatures drop to 68°F or rise above 140°F. Solid waste windrows need to be turned weekly or whenever the temperatures drop below 68°F or rise above 140°F. Piles should be turned less frequently in winter to maintain heat, and more frequently in summer, due to higher microbial activity.

Large piles may also reduce oxygen penetration to the center of the pile with the same result. Proper oxygenation favors small piles but these piles may not sustain proper temperatures, especially in winter. These components can be properly balanced by active management of compost size and turning frequency.

Notes

Chapter 3: Composting Methods

Notes

An outline of the operational process involved with an organic waste composting project is shown in the following chart.

Process Steps for a Generic Compost Operation

Collection
Delivery
Pre-Process (Optional)
Pile Formation
Decomposition ● Pile Combining ● Temperature Monitoring
Pile Turning
Curing
Shredding/Screening (Optional)
Marketing (End Use)

(Source: Municipal Scale Leaf and Yard Waste Composting, Fredric A. Waldstein, Ph.D, Wartburg College, Waverly, Iowa)

3.1 Land Application of Organic Materials

Direct land application of organic materials is not composting as defined in this guide. Composting is a technology initiated by man. However, natural decomposition is a process which can be utilized by a community if it manages the operation properly and has enough space.

Decomposition of land-applied organic material is carried out by macro organisms such as earthworms, soil insects, micro flora, and micro fauna. This degradation process occurs near the soil surface. Once these larger organisms size-reduce and consume some of the organic material, mesophilic organisms take over and decompose the material at a relatively slow rate.

Care should be taken when material is applied to the land. Uncomposted material is not a stable product. Therefore, as decomposition proceeds, nitrogen within the soil will be utilized during the process of degradation. This nitrogen will eventually be returned to the soil at the end of the decomposition process. However, if raw organic materials are applied to soils which support plants, nitrogen utilization during the composting process can affect plant health and growth. Thus, direct land application of organic

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material is viable only if the material is incorporated into the soil long before a crop is planted.

The main advantage to direct land application is that it costs a municipality less for equipment and operations than a composting operation. A written agreement is recommended between the community and the landowner(s) accepting organic material for land application. That agreement should include the legal description of the organic material management site, the total amount of organic material that will be disposed on the property and agreement by the landowner that the land in question will not be used for planting agricultural food crops until the next season.

For further information regarding land application of wastes, contact the Kansas Department of Health and Environment Bureau of Waste Management at (785) 296-1600 or the local Cooperative Extension Service. The Extension Service also has a pamphlet titled "Considerations for Direct Land Application of Organic Waste Products" written by William M. Eberle.

3.2 Windrow

In a turned windrow method the mixing, aeration, control of excess heat, and release of metabolic wastes (CO_2 and H_2O) are accomplished through mechanical turning of the compost windrows using equipment with the versatility of a front-end loader. This is the most common method used today, since most local units of government already own such equipment that can be available to successfully operate a composting project.

Slight odors may be produced early in the composting cycle, but these are usually not detectable more than a few yards away from the windrows.

After ten to eleven months, large curing piles are formed around the perimeter of the site, freeing the original area to accept the new yard waste collection. Costs are still quite low, as only monthly turning operations with a front-end loader are required after initial windrow formation.

A variation on this method is turning material with specialized, windrow turning equipment. These machines have the advantage of being able to completely turn a pile by shredding the windrows and totally agitating and aerating the mass of material. These machines can be pulled with a tractor or other piece of equipment that has a "creeper" gear (moves at a rate of less than one mile per hour). The limitation of a specialized windrow turning machine is that the pile height cannot exceed seven feet, which may be a concern during excessively cold winters or if there are site constraints. In addition, such specialized equipment is also capital-intensive and requires routine maintenance. A further discussion about processing and post-processing equipment is in Appendix D-2.

Notes

3.2.1 Windrow Combination - Rutger's Method

A low level technology method researched and recommended for composting yard wastes at Rutgers University is included here. This method involves combining two windrows one month after they have been formed. If yard wastes are delivered in October/November for example, they would be combined in December. After approximately one month, much of the initial oxygen demand of the waste has been exerted and the windrows have been reduced to about half the original size through decomposition and self-compaction.

Two windrows combined are about the size of each initial windrow (6 feet by 14 feet). Combining the windrows conserves heat during the winter. Combining should be done by moving and turning both windrows, not by placing one on top of the other. A maximum degree of mixing and fluffing is accomplished. The following spring, each windrow should again be turned. Turning mixes the materials, redistributes the moisture in the windrow, re-oxygenates the interior, and exposes the cool outer edges to the hotter internal temperatures. The result is an increased rate of decomposition and improved destruction of any pathogens and weed seeds. At this time, additional water may be added.

Windrows must be turned periodically to aerate and mix the compost material. Turning can be accomplished by either a front-end loader or a compost turner that straddles the rows. If the windrows are turned with front-end loaders, the recommended windrow size is 10 to 12 feet wide and 5 to 6 feet high with approximately 20 feet of space between windrows for equipment access; however, any convenient length can be used. The cross-section is usually made triangular, with the top width governed by the width of the base. If windrows are turned with a compost turner, the windrows may be formed slightly lower or higher, depending on the type of equipment used. If windrows are much higher than 6 feet they may pack down resulting in decreased aeration of the pile. Due to the self-insulating properties of too high a windrow, they may also overheat. In both cases, anaerobic conditions could be the result.

Additional turnings during the summer will increase the composting rate and product quality.

By the end of the summer the composting area must be cleared to create room for the incoming yard waste in the fall. The material can be moved and

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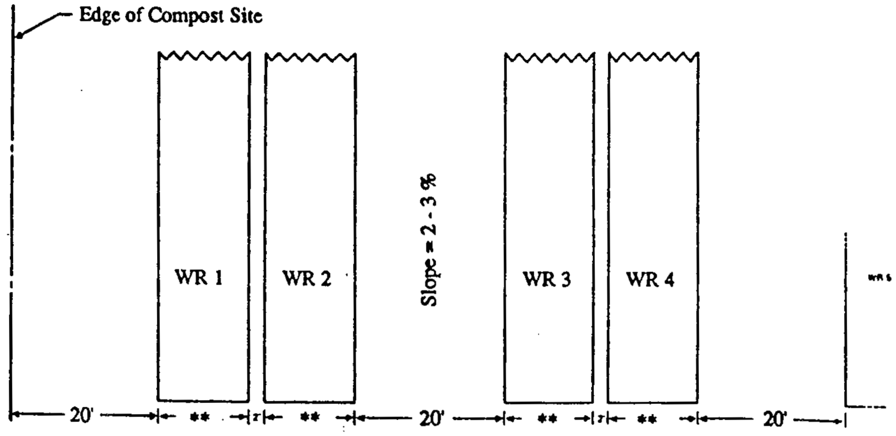
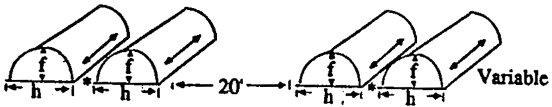
INITIAL WINDROW SPACING



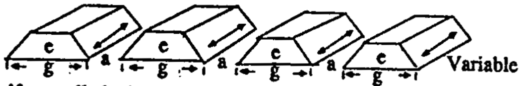
** windrows vary in width according to height

(Source: Connecticut DEP, 1989)

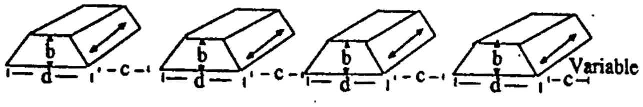
PROFILES OF WINDROWS



Front-end loader



Self-propelled windrow turning machine that straddles windrow



Front-end loader or tractor-mounted windrow turning machine, driven between windrows

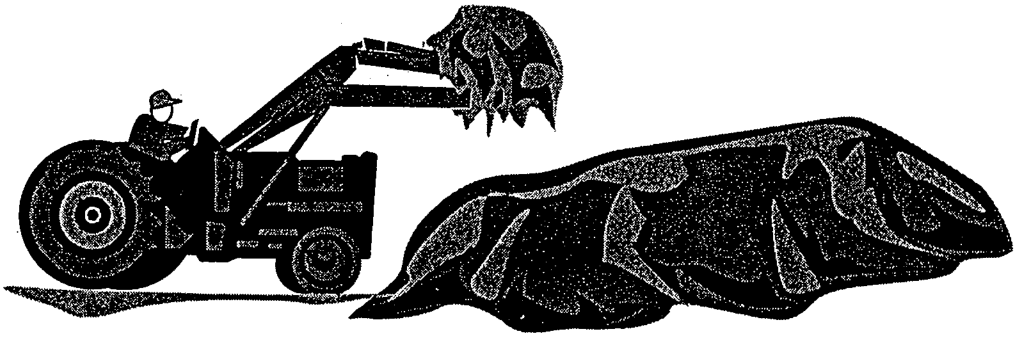
* = 2'	a = 3'	b = 5'
c = 8'	d = 14'	e = 5' - 7'
f = 6' - 12'	g = 14' - 18'	h = 10' - 20'

(Not to Scale)

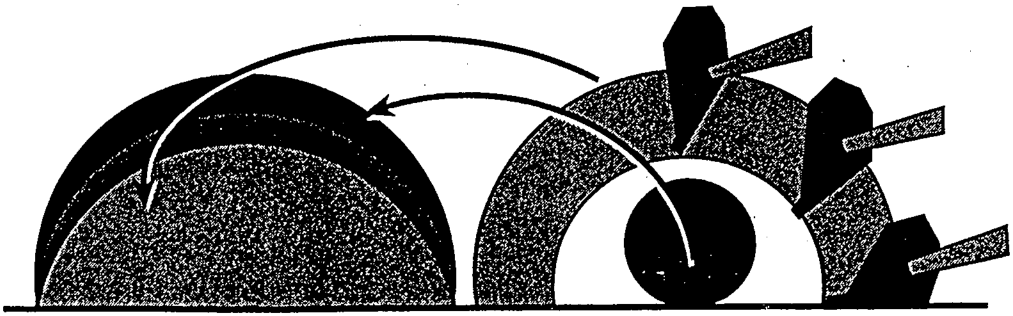
(Source: Dickson, 1989)

WINDROW TURNING FOR AERATION AND MIXING

Notes



Note: A front-end loader can do a good job of building and turning windrows, but can be labor intensive for large operations. (*Source: Guide for Community Yard Waste Composting in Kansas, KSU Cooperative Extension Service, 1997*)



Note: Turning with a front-end loader is accomplished by successively rolling the pile over the top so that the upper, cool material is turned to the bottom. Allow the material to fall gently to promote mixing and aeration. (*Source: Guide for Community Yard Waste Composting in Kansas, KSU Cooperative Extension Service, 1997*)

formed into a large curing pile around the perimeter of the site. The curing pile may be made as large as possible. Increased windrow depth is not a problem as the material is moderately well decomposed, has little oxygen demand and is unlikely to produce odors.

The following spring the material from the curing pile should be stabilized (not undergoing further decomposition) and ready for distribution. Shredding is a final optional step to improve the physical quality and appearance of the finished compost, making it more acceptable for many uses (Rugters University does not recommend shredding prior to windrow formation as they find it increases the matting of the leaves). The following table summarizes the Rutger's method using low-level technology for yard waste composting.

Notes

LOW-LEVEL TECHNOLOGY YARD WASTE COMPOSTING OPERATION

BASED ON THE RUTGER'S METHOD*

	Schedule		Time Required	
Operation	**Months**	**Flexibility**	**Front-end Loader**	**Operator Time Needed**
Prepare site	Sept. - Oct.	Yes	2 days**	2 days
Form windrows[a]	Late Oct. - Dec.	No	6 weeks	6 weeks
Combine	Dec. - Jan.	Yes	2 weeks	
Turn	Feb. - March - April	Yes	1 week	
Form curing pile	Aug. - Sept.	Yes	1 week	
Shred (optional)	March - May	Yes	4 weeks	4 weeks

***General Assumptions:**

(1) Site has been prepared to allow all necessary truck access and loader operation under any expected weather and ground conditions.

(2) Yard waste delivered in bulk (not bagged).

(3) Adequate supply of water on site.

(4) Daily supervision by a responsible person during periods of activity; regular checks at other times.

(5) Labor required for distribution of finished compost not considered.

****Other equipment such as a grader may be required.**

[a] Wetting leaves: average of 20 gallons per cubic yard.

Windrow size: six feet high by 12 to 14 feet wide.

Aisles: one to two feet wide for pairs of windrows, 12 to 16 feet wide between pairs.

Avoid compaction.

3.3 Aerated Static Pile

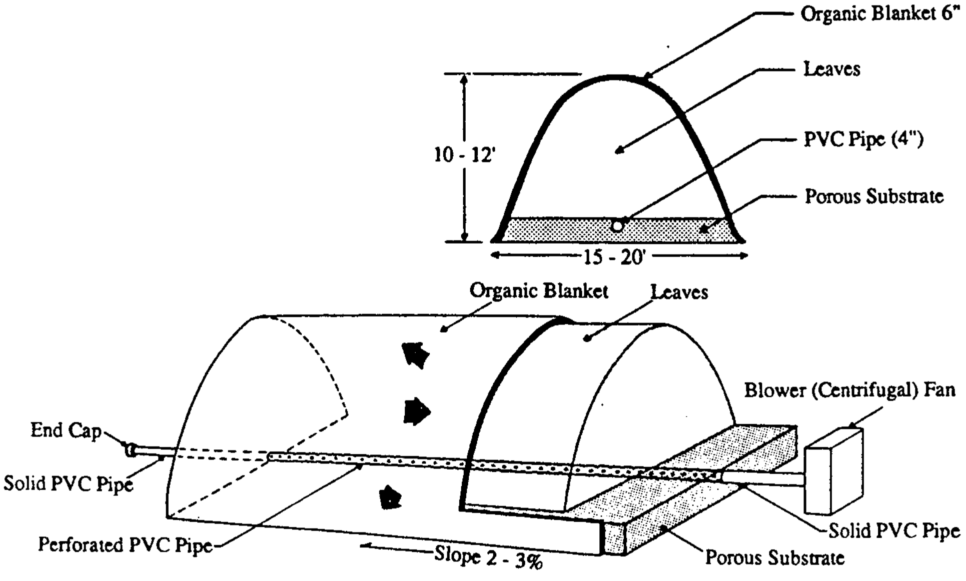
Composting is normally an aerobic process. As the yard wastes decompose, oxygen is consumed by the decay organisms and carbon dioxide and water are released. This creates a continuous demand for air within the compost pile. The windrow should be kept porous to allow for the intake of oxygen and release of carbon dioxide and water vapor.

Windrows can be aerated by either turning them or forcing air through them under positive (forced pressure) or negative (vacuum-induced) pressure. If windrows are turned, it is important that the inside material be placed on the outside and vice versa when the windrow is rebuilt. All the material needs to be exposed to the high interior temperatures to ensure that any pathogens and weed seeds are killed. Turning, in addition, evenly distributes the microorganisms and nutrients which speed up decomposition.

Front-end loaders and compost turners are two commonly used pieces of equipment for turning windrows. Small units are side mounted on front-end loaders that are driven between the windrows. See Appendix D-2 for information on turning equipment.

AERATED STATIC PILE PROFILE

Note: Piping size and substrate thickness not in relative proportion to pile height and width.



(*Source: Connecticut DEP, 1989*)

An alternative option to turning is to aerate the piles by using forced pressure aeration through the use of blowers. The aerated pile method of composting was initially developed for composting sewage sludge at the Beltsville Agricultural Research Center in Maryland. This method is used to compost feed stock that is moist (i.e., sewage sludge) or to compost mixed municipal solid waste. It involves laying the shredded, mixed feed stock on a prepared base (i.e., wood chips or unscreened compost) over a loop of perforated plastic pipe that is approximately 4" in diameter. The loop of perforated pipe is connected to a blower. Air can either be pulled (vacuum induced mode) or pushed into the pile (forced pressure mode). The windrows are usually covered with a layer of finished compost to reduce evaporation and to insulate the compost.

3.4 In-vessel

In-vessel composting encompasses a system involving mechanical agitation, forced aeration and enclosure within a building. In-vessel systems are generally not economically feasible for composting yard waste alone, but may be appropriate for source separated, municipal solid waste, and sewage sludge. The advantages include fast processing, avoidance of weather problems, and better process and odor control.

3.5 Sewage Sludge

Sewage sludge composting with yard waste should be considered if sludge disposal is an issue. But since this method requires higher capital cost technology, yard waste composting by itself should not be the motivating force.

Leaves in particular, can be added to sewage sludge to provide a bulking agent for the sludge. The leaves provide a carbon nutrient source and increase the number of voids (air spaces) to improve air passage for process temperature control, addition of oxygen, and removal of excess moisture. Sewage sludge composting involves environmental and health concerns such as pathogens, metals and miscellaneous contaminants beyond those associated with yard waste composting, and requires additional approvals and/or permits from the Kansas Department of Health and Environment, Bureau of Water. They can be contacted by mail at Forbes Field, Building 283, Topeka, KS 66620, or by phone at (785) 296-5500. It should be noted, however, that combining yard waste with sludge could serve as an alternative to the separate composting of yard waste and avoid a portion of expenditures for bulking agents in a sludge composting program. Composting yard waste with sewage sludge would normally be an option with the forced aeration and in-vessel methods; however, land application of sewage sludge is also permissible.

Notes

3.6 Backyard Composting

When siting a municipal scale yard waste project, planners should educate citizens in the method of backyard composting. Backyard composting involves the composting of leaves and other yard wastes on a small scale within the confines of one's own property. This method is particularly appropriate for areas where the residences are located on one-half acre plots or larger. Backyard composting should be encouraged as residents benefit from readily available compost. From a solid waste management perspective, backyard composting is a "waste reduction" strategy, rather than a form of recycling. Every ton of yard waste composted in backyards is a ton of material eliminated from being picked-up, transported, and deposited at a municipal scale project site. Overtime, this practice will translate into substantial savings for a community.

Information on backyard composting is available through the local Extension Service Offices, Master Composter Programs, and the Kansas Don't Spoil It campaign.

Notes

Chapter 4: Yard Waste Generation Rates and Collection Methods

Notes

4.1 Yard Waste Volumes

As with other recyclables, the more convenient the collection service, the higher the participation rate. Consequently, the volume of yard waste managed at a municipal composting site will vary with the size of the area serviced, the method of collection, and the convenience of the collection site to residents and independent haulers.

A typical Kansas urban area may generate approximately 4.0 pounds of residential wastes per person per day, of which 10-30%, by weight, may be yard wastes. Rural areas generally do not generate quite as much yard waste as the urban areas.

The density of yard waste varies significantly but averages about 350 pounds per cubic yard when collected. Although municipal waste generation is typically estimated on a per capita basis, the relationship between population and generation rates for yard wastes varies widely according to community characteristics such as population density, number of trees, and average lawn size. The following table shows the wide range of correlation between population and amount of yard waste collected by six U.S. cities. The number of dwelling units may be a more useful starting point for estimating generation rates for yard wastes. Appendix E offers general guidelines and worksheets that may be helpful in estimating generation rates for the community and the amount of land necessary for composting.

ANNUAL YARD WASTE COLLECTION OF SIX U.S. CITIES

City	Population	Yard Waste Collected (yd^3)
Webster Grove, MO	27,500	13,500
Wellesley, MA	28,000	25,000
Tenafly, NJ	15,000	45,000
Westfield, NJ	34,000	35,000
Madison, WI	174,750*	26,000**
West Bend, WI	21,500	4,350

*1989 estimated population **Assumes 300 lbs/yd^3

Notes

The types and amount of yard waste generated by the community also varies significantly throughout the year. Leaves account for most of the yard wastes generated from October through November, with about a six-week collection period. From April through October, for approximately 28 weeks, grass clippings, shrub prunings, trees, and garden wastes predominate.

Although a community will need to estimate the amount of yard waste that will be composted in the first year in order to establish an adequate site, the only accurate generation rates for any community will come from recording the amounts that are actually collected and delivered to the composting site during the first few years of operations. Since very little data exists for community yard waste volumes, only rough estimates can be calculated at this time. The following table highlights estimated Kansas yard waste by weight in tons.

ESTIMATED COMPOSITION OF KANSAS' WASTE STREAM*

Waste Component	Weight In Tons
Newspapers	114,240
Corrugated Containers (OCC)	240,070
Office Papers	87,870
Magazines	39,920
Mixed Paper	197,760
HDPE & PET	12,020
Other Plastics	106,660
Aluminum Cans	18,590
Other Aluminum Packaging	3,620
Steel Cans	31,810
Other Steel Packaging	1,710
Major Appliances	28,050
Glass Containers	83,430
Textiles	43,040
Yard Trimmings	227,700
Food Waste	173,250
Lead Acid Batteries	15,060
Wood Packaging	57,250
Other Durable Goods	246,700
Other Miscellaneous Organics	181,670
Other Miscellaneous Inorganics	28,210
C&D Wastes	506,500
Industrial Process Waste	1,298,200
Waste Oil	45,200
Tires	27,000
Household Hazardous Waste	9,500
Trees & Brush	54,500
Sludges (wwtp & car wash)	88,300
Others	285,600
Total Solid Wastes	4,245,900

(*Source: Franklin Associates, Ltd.*)

4.2 Yardwaste Collection

Decision-makers for cities or counties providing for yard waste collection must make a series of choices about collection techniques and equipment. Since collection techniques and equipment choices impact collection and processing costs and the quality of the end product, several collection options should be considered before a decision is made. The best combination of techniques and equipment for a given municipality is the one which most efficiently provides the compost required by the end user. For instance, yard waste can be collected bagged or unbagged. Bagged yard waste typically has little extraneous material and can be collected quickly with a standard compactor truck. However, labor is required at the composting site to remove the yard waste from the bags. Conversely, unbagged yard waste can be collected with a vacuum truck or a front loader. This process is more time-consuming and the choice of equipment is less obvious. The vacuum works well on dry yard waste; the front loader is more efficient for wet or frozen yard waste material. In addition, the amount of extraneous material is likely to be higher than when yard waste is bagged.

Notes

Woody materials such as trimmings and branches need to be separated from leaves and grass for size reduction prior to being added to the compost pile. Be aware that the presence of chips in compost may limit its potential end use.

Information regarding yard waste collection equipment is found in Appendix D-1 and D-2. In using this information to design an appropriate collection approach, the following issues should be considered:

(1) Capital, operating, and maintenance costs of equipment;

(2) Availability and cost of labor;

(3) Convenience for residents and businesses;

(4) Cost of bags;

(5) Existing equipment;

(6) Effectiveness in excluding extraneous material;

(7) Susceptibility to adverse weather;

(8) Hazards associated with placing yard waste at curb or in street;

(9) Potential noise and dust from collection equipment.

Drop-off Sites

Drop-off sites will be used to a greater extent if they are well-advertised. Leaflets or newspaper ads with a map and the hours the site is open will enhance public awareness of the new program. Residents of small

Notes

communities may also be encouraged to empty their own yard waste, saving the bags for reuse.

Collection Schedules

New collection methods and schedules will run more smoothly if residents are well-informed. Newspaper articles, television and radio spots, and neighborhood promotion prior to collection days will increase the level of compliance. If special bags must be purchased for yard wastes, this fact should be advertised along with the purchase locations.

4.3 Public Information and Involvement

Any community composting program will be more successful if it is accompanied by a well-organized and vigorous public information campaign. Because citizens are the generators of a significant portion of the yard wastes to be treated, their cooperation is essential. If citizens understand why the community is composting yard wastes, how the system is organized, and what the participant's role is in the program, increased participation will likely occur.

Begin planning public awareness and participation well in advance: two months should be considered a minimum when developing a time line/plan. Contacting the public can be a formidable task. In preparing information to be released to both print media and nonprint media sources, work with the following considerations:

- Who is the audience?
- What is the goal?
- Keep the message simple
- Avoid times when other media publicity is heavy (election time, holidays)

The extent of publicity will depend upon financial resources. A limited budget is not a hindrance to good publicity - there are many low cost ways to publicize.

The following table lists several vehicles of communication, divided into three cost categories. Low cost activities require only photocopying and mailing expenses. Medium cost vehicles may require the work of a graphic artist or printer, or may involve duplicating several thousand copies. High cost activities will require a large expenditure, up to several thousand dollars.

Notes

METHODS OF PUBLICITY

Low Cost	**Medium Cost**	**High Cost**
News releases	Flyers	Commercials, T.V., radio
News advisories	Posters	Billboards
Public Service Announcements	Fact Sheets	Media events
Community Calender Announcements	Briefing papers	Calendars
Letters to the Editor	Media events	Advertisements
News articles	Slide show	Public Relations Firm
Newsletter articles		
Speeches		
Guest spots on radio, T.V.		
Poster Contests		
Church bulletin notices		

Vehicles of communication can be divided into two categories:

1. *Publicity with the news media;*
2. *Publicity without the news media.*

4.3.1 Using the News Media

The more newsworthy the project, the more likely the publicity via the news media. The following rules for news media contact which should be observed:

1. Always be honest.

Notes

2. Do not expect special treatment, there are other newsworthy issues every day.

3. Be courteous and professional. Provide concise information.

4. When in doubt, ask procedure questions of journalists.

5. Present "news" from the public's perspective.

News Releases

News releases are used to inform the media about a project. A news release should concisely answer the who, what, when, where, why, and how of the item.

Checklist for a proper news release: (Contact the newspaper office to be used for further assistance in preparing a news release.)

1. 8 ½" x 11" paper.

2. Margins: 1 ½" bottom, sides; 2 ½" from top.

3. Typed, double spaced, one side only.

4. Dated.

5. Release instructions.

6. Check names, dates, spelling, numerical data.

7. Double check above.

8. Concise information, snappy introduction.

9. Proper pagination.

10. -More- at bottom of page 1; ###, -30-, or - (initials) - at end of release.

11. Send out two (2) days in advance of release date, one to editor and one to reporter that would cover the story.

12. Staple multiple releases.

News Advisories

Notes

News advisories alert the press to an upcoming event. A news advisory is not a news release, but gives details about the event, which is where the news will be. Advisories should be sent out at least one week prior to the event. As in a news release, the advisory should be dated and contact names, addresses, and telephone numbers should be included.

Checklist for a proper news advisory:

1. 8 ½" x 11" paper.
2. Typed, one side only.
3. Dated.
4. Contact name, address, telephone number.
5. Check data, dates, spelling.
6. Double check above.
7. Concise.
8. Proper pagination.
9. -More- at bottom of page 1; ###, -30-, or - (initials) - at end of release.
10. Send out at least 1 week in advance.

Public Service Announcements (PSAs)

Public Service Announcements are written statements sent to radio stations. The announcement(s) will be aired at the station's convenience. To be most efficient, prepare 10-, 20-, or 30- second PSAs. Announcers read at the rate of 24-27 words in 10 seconds. Most stations air announcements of this length. The message should be concise, and flow well when read aloud. It should be written as a script; this does not mean that it will not be edited, but prepare the PSA as the information is to be transferred to the listening audience.

PSAs should be typed on 8 ½" x 11" paper, double spaced in all capital letters. Include a date of release; instructions for airing; broadcast length;

Notes

names, address, and phone numbers of contacts, and an indication that the PSA is in audio.

Note that this release is general. Radio serves a broad area, and if the message is too specific (i.e. only for a city or county) its chances of airing are less. Thus, broaden the message and encourage people to call for more information. Also, a handsome letterhead and neat copy will attract a public service director's eye.

Community Calendar Announcement (CCA)

Many radio stations have community calendars, which air announcements about special events. A CCA is very similar to a PSA; the concisely written copy is a script which, with editing, will be read. Usually 30 seconds is provided for the CCA.

Other

There are other ways to contact the media, although the methods listed above are most popular and effective. These include news conferences; news events; letters to the editor; broadcast news releases (for television); and appearing on talk shows. Consult references in Appendix G for further public announcement information.

A news event or conference attracts attention to a program. A news event is an informal conference designed to provide the visual media, particularly television, with news material. Such events have a variety of formats. Listed below are guidelines for organizing media happenings:

1. Make the news conference visually interesting and "action packed".
2. Invite key people; for example, county commissioners, the mayor, city council, local celebrities. (Written invitation only.)
3. Select a time when competing news would be minimal; weekends are often good.
4. Put one person in charge, this avoids overlap and gaps.
5. Provide gimmicks to attract the public, such as give-aways, poster contests, prize drawings, refreshments, etc.

6. Begin planning - at least two months in advance of the media event. Send written invitations to key community people and professionals.
7. Alert the media via a news advisory 5-7 days before the event.
8. Send a news release 3-5 days before the event.
9. Call guests to confirm attendance and answer any questions.
10. Be brief.

Notes

4.3.2 Publicity Without The News Media

In addition to the news media there are other ways to communicate and encourage participation in a community's composting program. Example of publicity without the news media includes:

1. Flyers
2. Posters
3. Fact sheets
4. Briefing paper
5. Church publications
6. Letters to the editor
7. Newsletters
8. Other

Flyers

Flyers are effective messengers. They can be simple photo-copies or folded, off-set printed brochures. Factors to consider include:

1. Provide the who, what, when, where, why, and how of the program.
2. If people are directed to a specific location, include a map.
3. When working with a local organization it may be useful to use that organization's letterhead.

Notes

4. Keep the flyer neat, clean, and upbeat. Use colorful paper and print.

5. Use the logo liberally to generate familiarity with the program.

Flyers should be distributed door-to-door, either via bulk mail or by messengers. Remember, it is illegal to put anything but mail in a mail box. Make sure delivery will be supervised to ensure the information is delivered properly.

Posters

Posters are of questionable usefulness as a means of eliciting a desired response, however, they are helpful as reminders. The most effective poster will be one which is attractive (colorful, eye-catching), clever, and simple. Employ a graphic artist to design a poster. Keep it small; many businesses have a limit of 11" x 17" for posters.

Fact Sheets

Fact sheets are useful to answer citizens questions about a topic. Write fact sheets to a general audience, and attempt to answer anticipated questions. These should be periodically updated. Fact sheets are useful for distribution to groups and telephone callers.

Briefing Paper

A briefing paper is similar to a fact sheet, but provides more specific information about the program. Use the briefing paper as background for the media, to educate politicians and decision-makers, and to explain the program to other professionals.

Using Church Publications

Many churches and synagogues are willing to publicize programs. To initiate contact, send a letter to the clergy, requesting an announcement. Include a briefing paper. A follow-up telephone call would be useful.

Letters To The Editor

When appropriate, a letter to the editor of a newspaper can be useful. Keep the letter short; usually four paragraphs are sufficient. Send a cover letter with the item requested to be published.

Notes

Newsletters

Many communities and organizations publish a monthly or quarterly newsletter. It may be possible to request an announcement or article or insert a flyer in the newsletter, thus eliminating flyer-distribution costs. Contact the editor and offer to draft an article. Most often, the draft copy is included in full.

School Programs

Most schools through their science curriculum are happy to have an "expert" come in and talk about environmental subjects. Many of the printed materials available are made age appropriate for schools.

Kansas Don't Spoil It!

This campaign provides posters and brochures that can be customized to include your facility information. Newspaper, radio, and TV public service announcements are also available. Contact the Kansas Department of Health and Environment, Bureau of Waste Management at (785) 296-1600 for further information. (See Appendix H)

Other

There are many other ways to publicize a program. With financial resources, billboards, television or radio advertisements, calendars, and newspaper advertisements may be purchased. When considering these publicity campaigns, consultation with a public relations professional is recommended.

Notes

Chapter 5: Site Selection

Notes

Proper siting is a prerequisite to the establishment of a safe and effective yard waste composting facility. Design requirements, and to some extent operations, are influenced by site conditions. Operators should take care in selecting a suitable site as a means of controlling design/construction costs and operational problems over the life of the facility.

Three primary considerations should drive the site selection process:

- Area - Site must be large enough to contain a composting facility with the capacity to easily process projected volumes of yard waste and to provide room for storage of finished compost.
- Protection of surface and ground water - Site should be evaluated for its potential impact on waters of the state. Of primary concern are proximity to wetlands, floodplains, and surface waters and the depth of groundwater.
- Relationship between site and surrounding land uses - Site should be adequately buffered from sensitive adjacent land uses such as residences, schools, and parks.

The anticipated type and volume of waste must be known to determine land and facility needs. Volume and waste type information can be obtained from:

- county solid waste management plans;
- records of hauling companies;
- annual averages;
- seasonal fluctuations; and
- records from existing facilities.

5.1 Site Area Requirements

1. The space needed for the active composting site depends on the degree of technology used to compost, i.e. the lower the level of composting technology, the lower the cost. This lower level of technology

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does however, increase the requirements for available space, buffer size, and composting time.

2. For yard waste composting facilities only, a minimum of one acre of land should be used for planning purposes for every 6,000 cubic yards of yard waste.

3. The amount of land needed for land application of yard waste varies according to the amount of material applied. Generally, the requirements are relatively non-specific as long as application rates do not exceed crop needs. The Cooperative Extension Service has a pamphlet titled "Considerations for Direct Land Application of Organic Waste Products" written by William M. Eberle which provides helpful information on all aspects of direct land application.

Three other facility types are proposed in the draft KDHE rules and regulations for composting included in Appendix I. These are agricultural waste, source separated waste, and municipal solid waste. The facility design engineer must justify the amount of land planned for the facility by submitting design calculations to the Bureau of Waste Management Permits Section of the Department of Health and Environment, (785) 296-1600.

5.2 Location

Where a facility is located can be as important as how the facility operates in terms of public usage and acceptance. The community planner should assess the general location of site with particular attention to the impact of traffic on neighborhoods along the major delivery routes. A second concern is how centrally located the proposed site may be. Distance traveled to site by residents and/or collection vehicles may affect cost or participation rate. A site which requires delivery routes through densely populated areas would receive the lowest rating. A site which is centrally located in a sparsely populated area would rate high.

5.3 Zoning/Land Use

If local zoning ordinances do not allow composting at a proposed location, in most cases, the only alternative is to ask for a variance or find a new location. The compost operation should be in compliance with local zoning and compatible with adjacent land use. Some possible compatible land uses would include commercial, industrial, or agricultural sections.

The following sections (5.4 - 5.8) describe factors which should be considered in locating a yard waste composting site. Specific requirements for all composting facilities are stated in the draft KDHE regulations found in Appendix I of this guide.

Notes

5.4 Topography

The site should be somewhat flat with a 1-3% slope, (an open field with a wooded buffer would be ideal), and remote from residential areas. The site should not be located on wetland or flood plains or on land with a high water table. Of critical importance is the need to locate away from "sensitive receptors" such as nursing homes or hospitals. Due to weakened immune systems, residents of these facilities would be at a greater risk to develop respiratory infections from exposure to the fungus, Aspergillus fumigatus, commonly found at compost facilities (see Section 8.3 for further information).

5.5 Buffer Zone

A buffer zone between the site activities and neighboring areas will minimize possible odor, noise, dust, and visual impacts. Provide at least 100 feet between the yard waste composting operation and any existing habitable buildings. Other types of facilities would require larger buffer areas.

5.6 Water Source

The need for an additional source of water (other than natural rainfall) at a compost site depends upon the type of composting operation: yard waste, agricultural waste, source separated waste, or municipal solid waste composting.

Yard waste composting projects normally require only natural rainfall to support the degradation process. The availability of a water source (other than natural rainwater) is important for the other types of composting projects.

Water is needed when moisture content within the pile falls below 40 percent (by weight). Water can be applied manually through a hose or from a water truck, or by a sprinkler or seep watering system, which could operate without the need of an attendant on-site.

Approximately 20 gallons of water are required for each cubic yard of very dry yard waste. Thus, for large operations, on-site water is a necessity. In addition, experience has shown that watering yard waste before windrow

Notes

formation or during a turning event will be more efficient, hence, requiring less water. This is because recently windrowed yard waste tends to shed water applied from above.

Facilities also need a source of water adequate for fire protection. Possible water sources include water trucks, fire hydrants, and fire ponds.

5.7 Groundwater/Bedrock

Distance to groundwater and/or bedrock is of critical concern. Enough soil should exist between the soil surface and subsurface waters or bedrock to assure that run-off is adequately diverted and mitigated during heavy precipitation rather than becoming an environmental concern. Conversely, a high water table or shallow depth to bedrock can increase the likelihood of standing surface water during heavy precipitation events. Such a situation should be avoided to prevent soaking the compost piles.

General drainage information can be obtained from U.S. Geological Survey topographical maps. Soil water table information is available from the Natural Resource Conservation Service County Soil Survey.

5.8 Floodplain Restrictions

Siting a composting facility in a floodplain is only allowed with site specific restrictions. During times of high water the windrows may impede water flow, and/or wastes could wash into the stream. Flooding of the site could pose serious operational difficulties, including problems with equipment access and operation. Flooding of the windrows also may lead to extensive anaerobic conditions, causing the additional problems of odor and slowed decomposition rate. Windrows should run up and down rather than across slopes, to allow runoff to move between rather than through windrows.

5.9 Soil Considerations

An ideal composting site will have moderate soil percolation, so that ponding will not be a problem. Where percolation is poor, or where an impervious surface is used, particular care must be taken to prevent ponding. An impervious surface such as a paved site offers advantages in terms of vehicle access, equipment operation, and groundwater protection, but these advantages must be weighed against the loss of direct contact between composting materials and soil microorganisms, as well as the difficulties in managing runoff. Section 6.1 discusses considerations regarding compost pad.

5.10 Ownership

Notes

Composting facilities can be placed on land currently owned or leased by the facility operator. If the land is leased, the lease should clearly specify operations intended to occur on the property. It is also possible to have a private group operate a composting facility on government owned property. In such cases, cover the operation with an umbrella insurance policy or be certain the private individual operating the facility has proper liability insurance protecting the individual and the unit of government in the event of a liability claim.

Notes

Chapter 6: Site Preparation

Notes

Once the site is selected, it must be prepared for composting operations. This includes the necessary clearing, grading, on-site road construction, and the construction of any planned structures as well as the preparation and/or construction of the preprocessing and the composting pad area. Any existing perimeter vegetation should be retained to help separate and buffer the operation from other surrounding land uses.

6.1 Compost Pad

Yard waste composting facilities require an all-weather surface for the unloading area made of materials permitting accessibility during inclement weather. However, the composting pad should also support the equipment that will be needed for the turning of the composting windrows, despite weather conditions.

Solid waste composting facilities require a cover and an impervious base that can support the weight of the compost and the proposed turning equipment. The permeability of the base must be less than 1 x 10-7 cm/sec. The design engineer should check with the Kansas Department of Health and Environment, Bureau of Waste Management to assure plans will be adequate for the anticipated materials.

6.2 Preprocessing Area

Additional space is needed at several stages of the composting process. Space is needed to unload incoming yard waste, mix and blend materials, chip brush, shred compost, screen compost, and load vehicles for distribution of the finished material.

In the event that degradable bags are used, provide a preprocessing area to tub-grind or open the bags of incoming waste to reduce volume. All bags must be broken open before processing the waste into windrows.

6.3 Curing/Storage Area

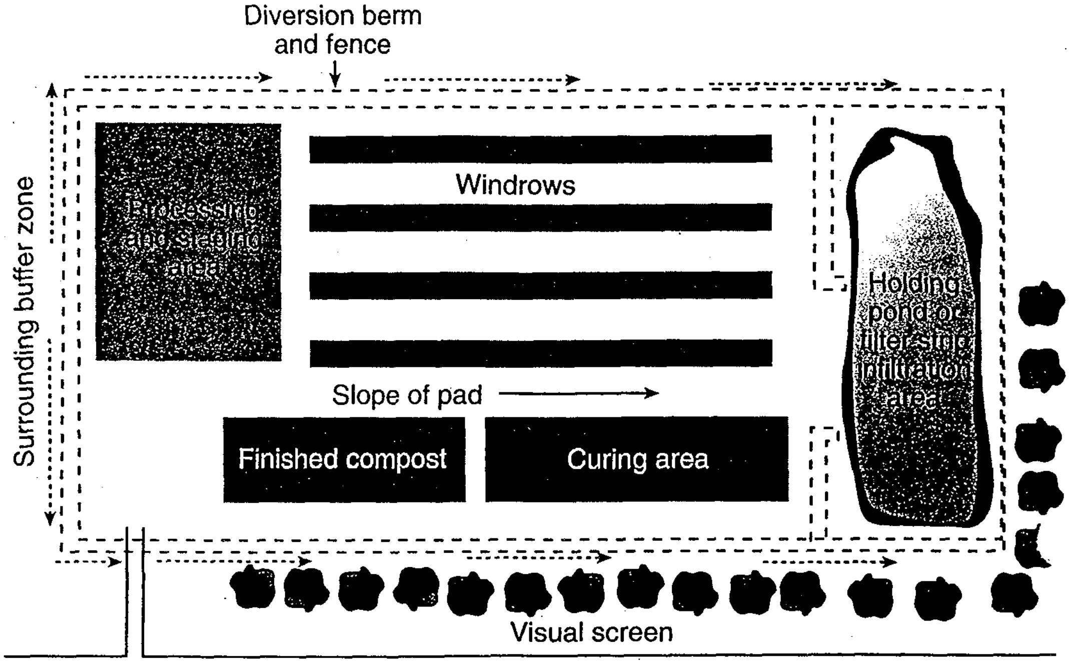
Space will also be needed for curing the yard waste compost after the active composting is finished and for storing the material prior to use or sale. This area should be at least 25 percent the size of the composting area.

Notes

6.4 Buffer Zone

Minimum distances between the composting facility and adjacent land uses have already been discussed in Section 5.1.4. If space permits, a larger buffer than required by law may be beneficial.

GENERIC COMPOST SITE LAYOUT



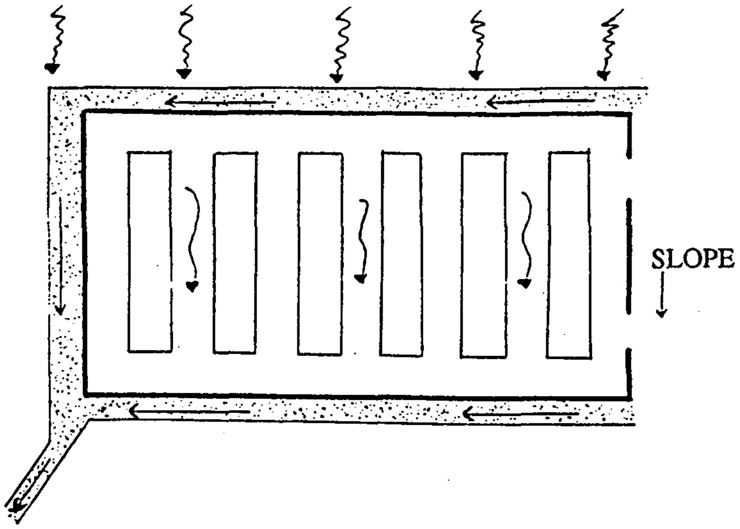
Example of yard waste composting site layout. (Arrows show direction of water flow.) (*Source: Guide for Community Yard Waste Composting in Kansas, KSU Cooperative Extension Service*)

6.5 Drainage Control

A system should be devised to prevent sediment or infiltration water from running off the site and into nearby surface waters. Diversion ditches should provide adequate run-off control at most sites. Run-off from up-slope should be diverted around the compost pad to prevent seepage into compost and curing piles. The run-off drainage system from the compost pad and up-slope area should be designed to accommodate an unusually long and heavy rainfall statistically shown to occur every 25 years.

Notes

GENERIC PRECIPITATION RUNOFF DIVERSION DESIGN



Runoff Should Be Diverted To Appropriate Methods of Treatment

(Source: National Corn Growers Association, St. Louis, MO)

6.6 Access Roads

Roads should be designed to permit orderly entrance and egress, even during episodes of inclement weather. Ideally, vehicles coming to the site with yard waste should enter at a different point from those exiting the site. If this is not possible, an area should be designated at the site as a waiting area to deposit materials.

6.6.1 On-Site Roads

Roads should be designed to facilitate quick and easy drop-off of yard waste. A circular traffic pattern is suggested where feasible. Consideration should be given to the seasonality of these operations, since heavy traffic is likely for a short period in the fall. Roads must be capable of handling all season operation of heavy equipment and support fire equipment if the need arises. While paving improves all weather mobility, it increases the cost of the facility and may contribute to run-off problems.

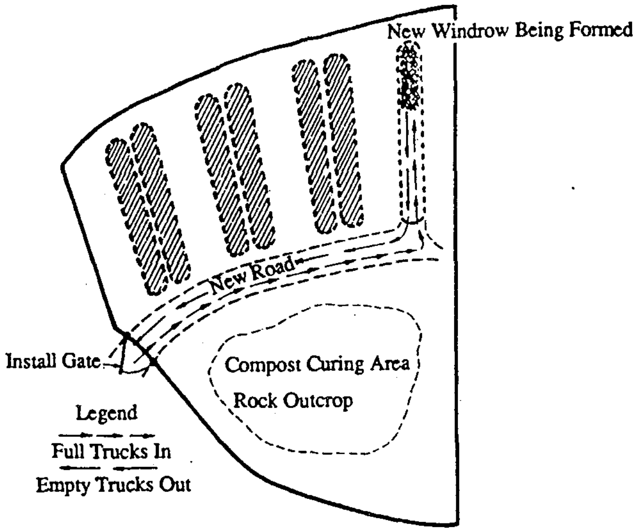
6.6.2 Access Control

Controlled access is required to prevent illegal dumping at the compost site. The required level of security depends on the potential for illegal dumping or vandalism.

Notes

A gate across the road at all access points is a minimum precaution. Gates to the site should only be open during times of deposition, monitoring, turning, or removal of compost. At these times, composting staff should be on the site to provide the necessary quality control.

VEHICLE TRAFFIC PATTERN



(Source: Worcester, Mass. Compost Project: Vehicle Traffic Pattern, as cited in Connecticut DEP, 1989)

6.7 Signs

All facilities must post a sign at the site entrance indicating the:

- Materials accepted;
- Facility name;
- Operating hours;
- Emergency phone number of the responsible official; and
- Permit number if applicable.

In addition, on-site signs may be required to direct vehicles to unloading areas and indicate traffic circulation patterns.

Chapter 7: Annual Site Preparation

Notes

Prior to each collection season, the site must be readied to allow necessary truck access and compost turning operations. The one part of the operation which has little scheduling flexibility is delivery of the collected wastes. Once yard waste is collected, it must be promptly formed into windrows.

The yearly site preparation should include regrading and road maintenance. Also, all refuse and debris from the previous year's operation should be removed. The draft regulations in Appendix I states finished compost can be held no longer than 12 months after it is finished curing. Annual site preparation should be scheduled any time after the active site has been cleared of the materials from the previous year (by formation of curing piles), but before the new collection season begins.

7.1 Waste Preparation

Preparation of yard waste for composting involves receiving and sorting the materials, reducing the size and mixing the yard waste, and if municipal solid waste composting is being done, wetting the waste may be necessary (refer to Section 5.6, Water Source for further information).

7.2 Receiving and Sorting

Yard waste should first be dropped off at a separate, hard-surface receiving area before being formed into windrows. A separate receiving area is needed since yard waste will arrive with varying degrees of compaction. Unacceptable materials that arrive with the yard waste must be sorted, collected and disposed of properly.

By breaking and fluffing up incoming yard waste materials in a receiving area prior to windrow formation, windrows will have a more uniform compaction, size, shape, and moisture content. In addition, delivery of yard wastes in a separate receiving area will speed up the unloading. Traffic control is also facilitated by having a separate unloading area.

If residents are responsible for delivering yard waste to the site, an operator must be present to monitor and prevent the drop off of unwanted materials. A record of the amount of yard waste received should also be kept by the operator. This information will be needed for planning purposes by the operator and management. This information will need to be included in the annual report to the KDHE for composting facilities.

Even with curbside collection, operator inspection of incoming wastes and a public education program are necessary to prevent delivery of unacceptable wastes at the facility. Unacceptable wastes may include plastic, metal, glass, large stones, pieces of wood, wire, rope, and other non yard waste items. These items are normally removed by hand sorting. The unwanted materials and any recyclables must be removed from the site at least weekly. Until these materials can be removed from the premises, these residuals must be stored in an area that will prevent vector problems and aesthetic degradation.

7.3 Windrow Formation

Windrows are relatively easy to construct and maintain. Immediately after grinding and mixing, the materials are placed by front-end loaders into parallel rows. Windrows should be about six (6) feet high and about 14 feet across at the base. Windrow formation should take place as soon as possible after yard wastes are received. If dumped yard wastes are allowed to sit for more than a day, odor problems may develop. For details on composting methods, refer to Chapter 3, Composting Methods.

7.4 Monitoring

The monitoring of yard waste should take into account factors such as temperatures, oxygen, moisture, and porosity. Optimum levels for each factor should be maintained. Turning the windrows is the one necessary mechanism that is used for control. A decision to turn should reflect the conditions both within and outside the piles. Ambient (outside) conditions, such as temperature, wind, and precipitation, are so variable that at times a set schedule for turnings may result in a slow down in the rate of decomposition. In essence, monitoring piles will insure optimum conditions and avoid unnecessary turning, and as such, keep costs to a minimum.

7.4.1 Temperature

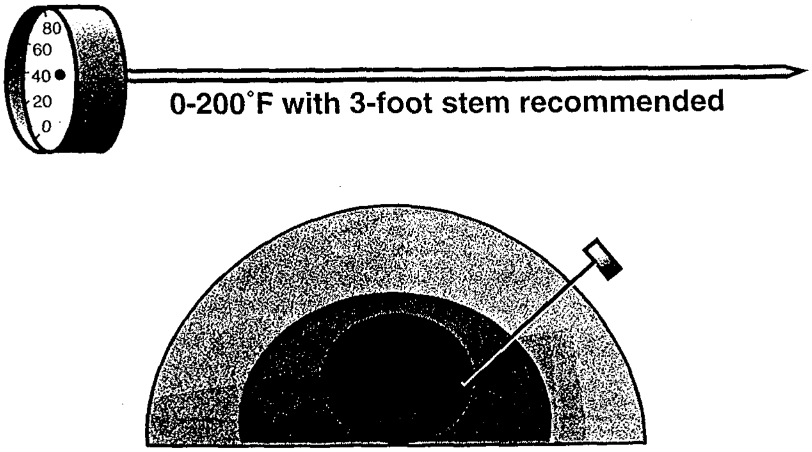
Temperature is the easiest variable to monitor, and it reflects how well other factors, such as oxygen and moisture content, are being maintained.

The thermometer most appropriate for a municipal scale yard waste composting operation should have a range of zero to 200°F, a three to five inch diameter dial, and an adjustable calibration screw. The stem of the thermometer should be steel (aluminum tends to bend easily), and the tip of the stem should be pointed. The cost for such thermometers range from $60 to $100. If woody material is being composted, a stronger, larger thermometer may be required. Refer to Appendix C for a list of thermometers.

Notes

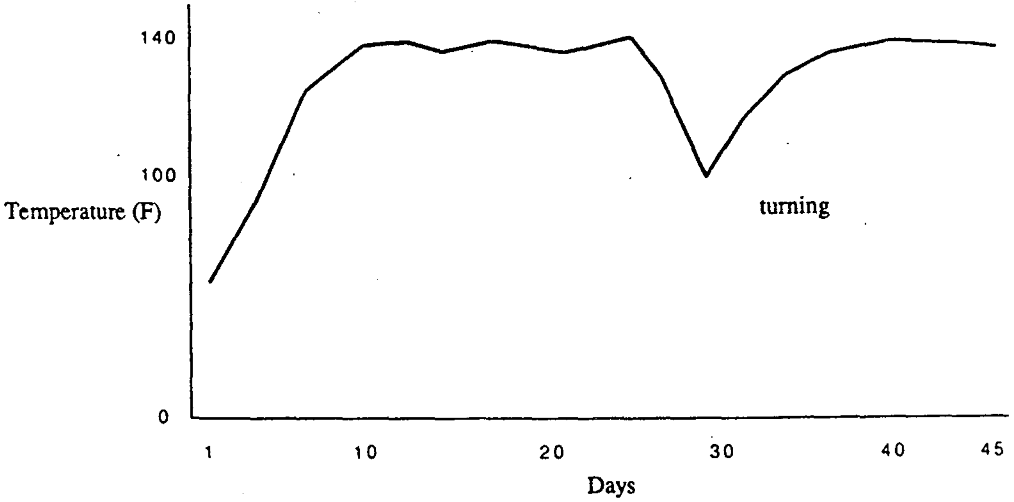
Windrow temperature measurements should be recorded daily to monitor the compost process and to determine when the compost is stable. Appendix A-2 provides a Sample Windrow temperature monitoring data sheet. Monitoring points should be at least every 75 feet along a windrow, since material coming onto a site can be quite varied in both its moisture content and mix of yard waste.

TEMPERATURE MEASUREMENT TECHNIQUE



(*Source: Guide for Community Yard Waste Composting in Kansas, KSU Cooperative Extension Service*)

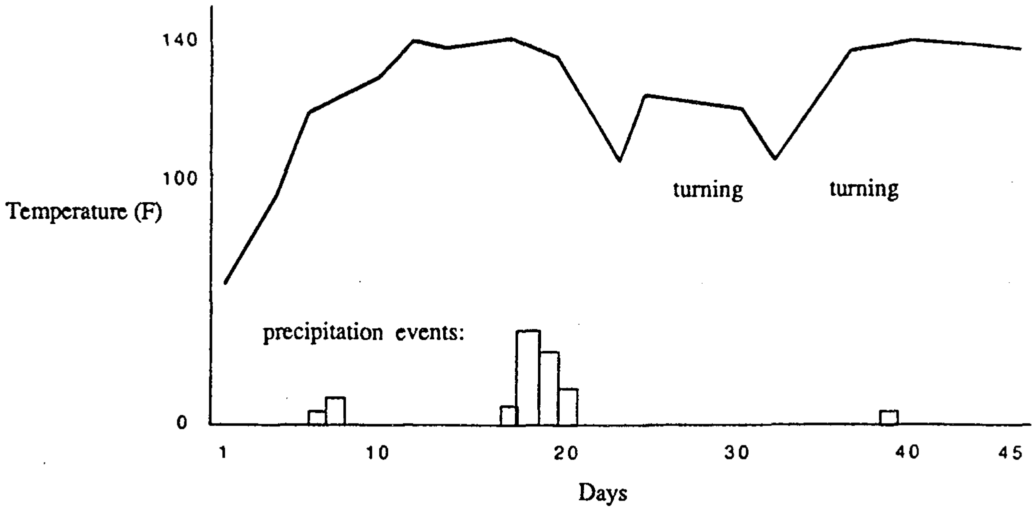
TYPICAL WINDROW TEMPERATURE RESPONSE TO OXYGEN AVAILABILITY



(*Source: National Corn Growers Association, St. Louis, Mo.*)

Notes

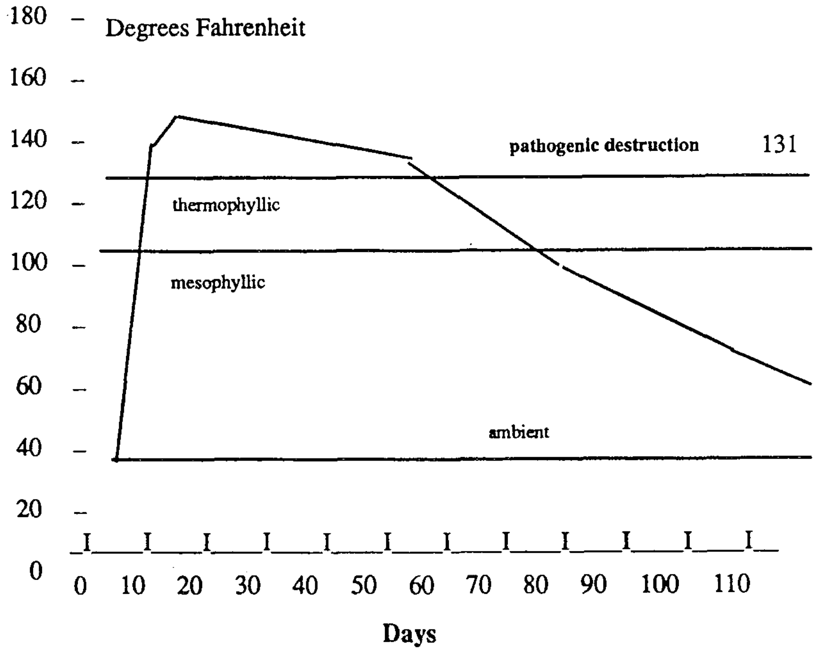
WINDROW TEMPERATURE RESPONSE TO HEAVY PRECIPITATION



Note: Two turnings may be required to remove excess moisture from a heavy precipitation event.

(Source: National Corn Growers Association, St. Louis, MO)

GENERIC GRAPHIC REPRESENTATION OF TEMPERATURE CHANGE WITHIN WINDROWS



(Source: Michigan DNR, 1989)

7.4.2 Moisture

Notes

Water is necessary for the microorganisms to survive. The optimum level of moisture is between 40 and 60 percent. This can be checked by squeezing a handful of compost, if just a few drops of water come out then the moisture content is correct. If the compost pile is too moist oxygen will be lacking and anaerobic conditions will occur which will produce odors. When the compost is too dry the microbes will not be active. Both conditions will cause the speed of composting to slow.

7.5 Curing

Curing allows the compost to attain a biologically stable condition. Microbial activity during curing continues, but at a slower rate than during actual composting. As the piles cure, less heat is generated by the microorganisms, and the pile begins to cool down.

Cooling of piles does not necessarily mean that the curing is complete; however, it is a sign of reduced microbial activity, and that could result from a lack of moisture or inadequate environmental conditions (moisture, pH, etc.).

Curing piles may be force-aerated, or passive aeration may be used with occasional turning from a few days to several weeks or months. The cured compost is then prepared for market. Depending on market needs, the compost may have to pass through a shredder and an additional screening step.

7.6 Screening

Screens are used to separate the compost from the non-compostable fraction. During the composting operation, the compostable fraction undergoes a significant size reduction, while the non-compostable fraction undergoes little or no size reduction.

Screening can be done before or after the curing process. Depending on the initial shredding process and the size of screen used, some larger compostable particles may enter the non-compostable stream during screening. One or more screens may be used as in an initial coarse screening, followed by a fine screening step. The non-compostable fraction retained on the coarse screen is sent to the landfill; compostable materials retained on finer screens may be returned to the beginning of the composting process.

Notes

Screened compost may contain inert particles, such as glass or plastics, that may have passed through the screen. Generally, such inert materials are present only in small quantities.

7.7 Storage

Once cured, the compost is similar in texture and appearance to soil. Since the compost is now reduced to approximately 25 percent of the volume of non-composted material, adequate space must be allocated for the on-site storage of finished compost.

One concern for compost storage is growth of unwanted plants. If yard waste is properly composted, weed seeds are destroyed. After curing, weeds can be transported to the storage pile by the wind. If plants are allowed to grow and seed, the compost will be contaminated to the point that special end user markets, such as garden stores, landscapers, nurseries and golf courses, may not want the product.

Depending on projected end use, the storage pile may need to be either covered or sent to end users in a relatively brief time. This should not be a concern for end uses such as landfill cover, public works projects, etc. Storage of cured compost is limited to 18 months on-site.

7.8 Other Considerations

7.8.1 Road Salt

Road salt used in ice and snow removal has not been found to be a problem with regard to high concentrations in yard waste composting. Generally, any concentration of salt that may be deposited on yard waste (during an early fall snowstorm or over the winter for those materials picked up in spring) becomes diluted with a larger amount of yard waste that have not been in contact with road salt.

7.8.2 Pesticides

Pesticides used on trees are normally confined to a few insecticides and possibly some fungicides. In a normal year, only a few trees will be selectively sprayed and in most instances will be treated early in the growing season (June-July). During those years of high insect infestation (e.g., gypsy moth caterpillars), a more intensive spraying program may be necessary. However, even in this case treatment will be completed early in the season

(May-June), and by the time yard waste and leaf fall occurs, the pesticides will be significantly degraded.

Notes

Pesticides and herbicides used by most homeowners and lawn care services are designed to work in the soil and on the lower sections of the plant. Early research results show there is little cause for concern that such chemicals will impact the composting process. By waiting 24-48 hours after applying yard chemicals, little or no chemicals remain on that portion of the grass cut by the mower. Chemical residue on or in yard waste compost is not detectable or only detectable at very low concentrations.

7.8.3 Woody Materials

Wood tends to decompose very slowly, making composting of woody materials impractical in most cases. Thus, large woody materials should not be intentionally incorporated in yard waste composting windrows. Small amounts of incidentally included branches and twigs pose little problem.

Tree trunks and large branches can usually be easily given away or even sold as firewood, if cut to appropriate lengths. For smaller diameter woody materials, chipping produces a useful mulch. Various communities have had great success using wood chips as mulch or bedding for municipal landscaping, park pathways, and school playgrounds. Residents also appreciate free wood chips for use in their yards.

Wood chips are valuable at the compost site to form roads and all-weather work surfaces. Small quantities of wood chips mixed in with the compost will not adversely effect the quality of the final product.

7.8.4 Pine Needles

Pine needles can be successfully composted if they are mixed with grass and yard waste. However, since pine needles decompose very slowly, the formation of windrows containing almost exclusively pine needles should be avoided. Note: Christmas trees should be treated as woody materials.

Notes

Chapter 8: Health and Environmental Concerns

Notes

The process of composting is not without its concerns both to the environment, and to the health of the staff and surrounding population. The generation of leachate through run-off waters, the presence of pathogens, and nuisance conditions including odor and dust are issues that must be considered and addressed in the planning phase of the project.

The type of leachate generated will be dependent, in part, on the type of compost as well as its age.

8.1 Leachate

Leachate from compost should be collected and treated to prevent contamination of ground and/or surface waters. Control includes:

- Directing leachate from compost curing and storage areas to a leachate holding area.
- Installing liner systems of either low permeable soils (clay) or synthetic materials.
- Using liner under drain pipes to collect leachate for treatment.
- Indoor curing and storage of compost to eliminate infiltration of precipitation.

Once the leachate is collected, the simplest way to handle it is to reintroduce it into the compost site. Excess amounts beyond the moisture needs of the pile could be transported to a municipal waste water treatment plant.

8.2 Pathogens

The primary objective of monitoring a compost pile's temperature is to ensure that temperatures become high enough to kill any pathogens or disease causing microorganisms present. Included in the proposed regulations, see Appendix I, are specific operating requirements for solid waste composting facilities regarding temperature control for pathogen destruction. Pathogens usually do not pose a problem in yard waste compost.

Notes

Pathogens found in sewage sludge and/or refuse can be divided into four groups: bacteria, virus, protozoa, and helminths (worms). Also, several pathogenic fungi are present in municipal solid waste compost.

Destruction of most pathogens is achieved by high temperatures (up to 160 °F) that occur during the composting process. To ensure pathogen destruction during the active decomposition phase it is critical to expose all the compost material to high temperatures. In the windrow method, the outside areas of lower temperatures must be turned and mixed with internal areas of higher temperatures. When the compost is not turned, as in aerated static piles, cold zones and pockets may occur. Therefore, it is advisable to turn the aerated static piles to mix all materials thoroughly. Clumps of compost must also be broken as they will not heat sufficiently.

THERMAL DEATH POINTS OF CERTAIN DISEASE - CAUSING ORGANISMS IN MAN[a]

Organisms	**Temperature (°C)**
Salmonella typhosa	Growth ceases at 46 C; death, 30 min. at 55-60 C
Salmonella spp	Death, 15-20 min. at 60 C; 1 hr at 55 C
Escherichia coli	Death, 15-20 min. at 60 C; 1 hr at 55 C
Endamoeba hisotlytica	Death, 68 C
Taenia saginata	Death, 5 min. at 71 C
Trichinella spiralis	Infectivity reduces as result of 1 hr. exposure at 50 C; death, 62-72 C
Necator americanus	Death, 50 min. at 45 C
Brucella abortus or sus	Death 3 min. at 61 C
Micrococcus pyogens var. aureus	Death, 10 min. at 50 C
Streptococcus pyogenes	Death, 10 min. at 54 C
Mycobacterium tuberculosis	Death, 15-20 min. at 66 C
var. hominis	
Mycobacterium diphtheriae	Death, 45 min. at 55 C
Shigella spp	Death, 1 hr at 55 C

[a] Golueke, C.G. Composting: *A Study of the Process and Its Principles,* The J.G. Press, Inc. Emmaus, Pennsylvania 18049, 1972. (110 pp)

Notes

SURVIVAL TIMES OF ANIMAL PATHOGENS IN THE SOIL AND ON PLANTS[a]

Organisms	Medium	Survival Time (Days)
Ascaris ova	soil	up to 7 years
	vegetables	27-35
Salmonella	typhosa	soil 29-70
	vegetables	31
Cholera vibrio	spinach, lettuce	22-23
	non-acid vegetables	2
Endamoeba histolytica	soil	8
	vegetables	3
Coliforms	grass	14
	tomatoes	35
Hookworm larvae	soil	6 weeks
Leptospira	soil	15-43
Polio virus	polluted water	20
Salmonella typhosa	radishes	53
	soil	74
Shigella	tomatoes	2-7
Tubercle bacilli	soil	6 months
Typhoid bacilli	soil	7-40

[a]Golueke, C.G. Biological Reclamation of Solid Wastes, The J.G. Press, Inc. Emmaus, Pennsylvania 18049, 1977 (249 pg.).

8.3 Fungi (Aspergillus fumigatus)

In addition to the pathogens previously mentioned, approximately 50 species of fungal organisms can cause disease. These fungi are considered to be secondary pathogens - they are not a primary concern to healthy individuals, but may affect people who have suppressed immune systems. Individuals with past or present respiratory infections, prolonged antibiotic or steroid treatment are also susceptible to fungal diseases.

Notes

A common fungus found in compost, soil, hay, wood, and foliage is *Aspergillus fumigatus*. In susceptible persons, *Aspergillus* can inhabit the lungs and form fungal infections. Composting promotes proliferation of *Aspergillus* since it is a thermophilic fungi (thermophilic organisms grow at high temperatures). Toward the end of the composting process, as the compost cools and dries, *Aspergillus* may exist in larger numbers. The spores are readily dispersed from dry and dusty compost piles and can either be inhaled or can enter the body through cuts and abrasions in the skin. Found everywhere in the environment, high levels of *Aspergillus* spores have been isolated from trash piles and yard waste compost. In addition, results of recent studies found a large percentage of compost workers tested positive for nose and throat cultures of *Aspergillus*. Section 10.13 of the Troubleshooting Guide provides alternatives for managing *Aspergillus fumigatus*.

8.4 Employee Health Concerns

Employee health at a compost facility should be of primary concern. The risk of infection in healthy individuals who work at compost facilities is low; however, persons who have asthma, diabetes, or suppressed immune systems should not work at a compost facility. The following guidelines are necessary to prevent illness:

- Workers must maintain high standards of hygiene, such as washing hands before meals/breaks and prior to going home.
- During dry weather, the composting area should be sprinkled with water to prevent dust dispersal.
- To reduce dust inhalation during dry conditions, workers should wear masks or respirators.
- Workers should be removed from the spore - dispersing part of the compost process, such as mechanical turning.
- Workers should wear safety shoes and glasses when operating a shredder.
- The composting facility should be located at a considerable distance from hospitals and residences.

Workers should be aware that disease producing microorganisms are a common occurrence in the composting work environment. In order to reduce the risk of disease, employees should be given a wash-up time prior to breaks, lunch and at the end of the shift. If shower facilities are not provided at the site, the employee should be informed of the importance of showering and an immediate change of clothing and shoes to reduce the risk of infection.

Notes

Cuts and bruises should receive prompt attention to prevent any contact with the waste material or feedstock.

8.5 Contamination and Heavy Metals

Depending on its origin, yard waste compost may be contaminated by lawn chemicals, toxic organisms, tree spray chemicals, automobile exhaust pollutants, broken glass, metals, weeds, animal wastes, plastics, and other foreign materials.

Proper monitoring procedures can eliminate or substantially reduce the potential for contamination. Further, a composting period of 12 to 18 months is believed to be sufficient for the degradation of most commonly used pesticide residues which may be present in yard wastes. Dilution of toxics also occurs as feedstocks are gathered from many sources and processed into a finished product.

8.5.1 Heavy Metals

The Kansas Administrative Regulations limit land applications of heavy metals in municipal sewage sludge and other solid waste compost (refer to Appendix I).

The metals of major concern from compost follow:

- Cadmium is the metal of most concern to human health and is often found in sludge, compost, and co-compost (due to plastics in the waste stream). Cadmium exposure to humans comes from grain products, vegetables and fruits where it is readily absorbed by the plants and accumulates on the edible portions.

- Zinc is one of the metals possible in sludge/solid waste of moderate concern to both plant and annual health. Plants have had as much as 300 ppm zinc present in their tissue without affecting a change. Zinc is a rare concern to humans because damage to the crops themselves occurs before plant tissue levels reach human toxic levels.

- Nickel and copper are extremely phytotoxic (toxic to plants). Signs of nickel toxicity in leafy vegetables, grasses and legumes begins at 50-100 ppm. Copper tends to bioaccumulate in the roots with levels of 20-30 ppm creating damage to plants.

Notes

- Lead toxicity in humans is high, occurring at 30 ppm in the diet. Lead is immobilized by phosphates in the soil and has never been observed to cause plant phytotoxicity after the land application of high lead sludges. Lead is found on the peel of unwashed vegetables grown on inner city soils with a high lead concentration.

Chapter 9: Quality and Site Controls

Notes

Quality control is necessary to avoid negative impacts on the environment. Quality control also reduces the likelihood for nuisance conditions that may adversely affect residents of the community.

Proper public education is the first consideration of a quality control program. By informing citizens what type of organic wastes will be accepted at the composting site, as well as how the materials should be separated and collected, a minimal amount of noncompostable materials will be incorporated into the windrows. Regardless of the public's efforts to minimize noncompostables in the yard waste collection system, all incoming waste should be carefully monitored to control the dumping of inappropriate wastes.

Those noncompostables that do enter the composting piles tend to "float" to the top of the pile as the volume of organic matter decreases due to the decomposition process. These noncompostables can be removed during the turning and curing pile formations. Finally, a screening step can be employed to remove any remaining objects missed from previous procedures. Quality control monitoring should continue throughout the entire composting process.

9.1 Green Wastes

To avoid odors, green wastes, such as grass and garden wastes, should not be composted alone, nor stored for long periods of time before incorporation into existing windrows. Because grass clippings are high in nitrogen and moisture, when added to an existing pile, green wastes enhances the composting conditions and increase the rate of degradation. Grass clippings (and yard waste) arriving in degradable bags may be left in the bags; however, the degradable bags should be opened by some means before composting.

9.2 Quality of the End Product

Contaminants are not likely to be present in yard waste composts. An analysis of the total concentration of heavy metals in solid waste compost is required. The end use of the compost will determine the amount of foreign material which will be acceptable in the finished compost. For home garden use or as a potting mix the compost will need to be screened to remove all foreign materials.

Notes

9.3 Site Control

Safety precautions usual to any operation using heavy machinery should be exercised. Heavy equipment can crush workers, shredders can send rocks flying, and broken bottles can cut hands; belts or chains can catch loose clothing, inhaled dust can cause breathing disorders (previously discussed in Section 8.0), and a simple injury may be fatal if an operator is working alone. Simple precautions including hard hats, steel-toed shoes, gloves, OSHA approved goggles, and dust masks will prevent health hazards from becoming worker safety problems.

Also, access control (discussed in section 6.6.2) should be designed with safety in mind. Public access should be restricted (if a drop off site is provided, make certain the area is secure) and adequate liability insurance should be maintained.

9.4 Record Keeping

The importance of record keeping cannot be over-emphasized. Operators should keep a log to track the volume, weight and origin of incoming yard waste. This data will be useful for:

- Developing estimates on the amount of compost that will be produced
- Determining the adequacy of the site for handling projected levels of yard waste
- Isolating the origin of contamination problems and
- Developing a cost/benefit analysis.

In addition, records of any problem(s) and the step(s) taken to mitigate the problem(s) may be valuable in resolving negative public relations.

Further record keeping includes temperature monitoring, approximate moisture content, and ambient weather conditions. The purpose of this monitoring indicates the composting method used, change of temperature over time, as well as providing an indication when pile turning will be needed. Graphic representation of internal pile conditions to external conditions will also demonstrate how effective operating procedures maintain optimum biological activity. Appendices A-2 and A-3 give examples of generic temperature monitoring record keeping sheets that could be used by a site operator.

Finally, records of analysis of the quality of finished solid waste compost should be developed and made available to prospective end use markets.

Notes

9.5 Contingency Plan

Operators must develop alternate plans for managing composting operations in the event that the compost operation is disrupted by natural disasters, fiscal problems, staffing shortages, or equipment failure. A permitted solid waste processing or disposal facility should be available as a backup measure.

If the composting facility is inoperable for a longer period than the site storage capacity will allow, no additional wastes should be accepted.

Notes

Chapter 10: Troubleshooting Guide

Notes

This chapter outlines potential pollution and nuisance problems which may arise as a consequence of poorly managed yard waste composting.

10.1 Odor

Odor is generally considered to be the most prevalent problem encountered at yard waste composting facilities.

- **Siting**

(1) Provide an adequate buffer between the composting operation and sensitive land uses.

(2) Locate sites downwind of sensitive uses.

- **Design**

(1) Place windrows at the center of the site and curing piles at the perimeter.

(2) Align windrows perpendicular to the topographical fall line, so water runs between the piles rather than through them, to minimize ponding.

- **Operation**

(1) Build windrows to proper height and shape.

(2) Form incoming yard waste into windrows promptly.

(3) Maintain proper temperature, moisture, and oxygen content with an effective turning schedule based on temperature and moisture monitoring.

(4) Time pile turnings to coincide with favorable wind conditions.

(5) Monitor incoming waste to limit the amount of putrescible material incorporated into windrows.

(6) Use of wood chip bed in windrows to decrease odors.

10.2 Run-Off

Run-off from yard waste composting operations may contain small quantities of heavy metals, insecticides, herbicides, and inorganic nutrients all of which can have a detrimental impact on surface and ground water if not properly managed.

- **Siting**

(1) Facilities must be sited in compliance with State Regulations (Refer to Appendix I).

(2) Avoid sites adjacent to lakes, rivers, and reservoirs.

(3) Avoid sites where the water table rises closer than 4 feet to the surface.

(4) Avoid steep slopes.

(5) Choose a site with soil capable of attenuating leaf drainage water.

(6) Avoid sites where the bedrock is less than 5 feet from the surface.

- **Design**

(1) Design a method to divert run-on from compost and curing piles.

(2) Design a method that will contain run-off on-site, and that will handle the run-off with minimal impact to the groundwater.

- **Operation**

(1) The concentration of heavy metal contaminants in yard waste can be reduced by prohibiting or limiting the volume of leaves collected by street sweepers that are incorporated into the compost pile.

(2) Plan for prompt disposal of noncompostable material.

10.3 Ponding

Standing water from yard waste caused by improper drainage. This will provide a place for mosquitos to breed. It can also cause equipment problems due to muddy conditions.

- **Siting**

(1) Grade site to 1-3% slope; avoid flat sites entirely.

- **Design**

(1) Lay out compost piles so that windrows are parallel with the slope of the land allowing water to drain between windrows.

(2) Berms to deflect storm water run-on help to prevent excess water from entering the site.

Notes

10.4 Leachate

Dark water that leaks from compost piles and often described as leachate. Harmless in small quantities, leachate will be absorbed beneficially into the soil, but can cause serious surface water contamination problems if it is associated with widespread ponding or run-off.

- **Operation**

(1) Regular turning of piles keeps leachate to a minimum.

(2) Watering piles in less quantity, layer by layer, rather than all at once will prevent leachate also.

(3) Leachate is usually caused by the compressed damp base of the pile and can be an indication of undesirable anaerobic conditions.

(4) Add water prudently. Use squeeze test to determine amount of water needed.

10.5 Slow Composting Rate

Implies that the material has failed to decompose and still looks much as it did when the material arrived.

- **Operation**

(1) Turning and shredding to mix moisture with food and expose nitrogen to carbon sources.

Notes

10.6 Inadequate Composting Rate

Implies the materials have failed to decompose likely as a result of poor design and operation.

- **Design**

(1) Piles too large, leading to anaerobic conditions. Make piles smaller. Add limestone if necessary to raise pH and control odors.

(2) Piles too small, leading to heat loss. Make pile 6 feet high. Colder regions may require greater height. Balance against need for control of anaerobic conditions.

- Operation

(1) Material too dry. Add water initially, or as corrective measure when turning.

(2) Uneven distribution of air, moisture or nutrients. Turn or shred pile, wetting if necessary.

10.7 Plant Toxicity

Uncured or improperly used compost can inhibit and kill plant growth (phytotoxicity). The nitrogen reaction in unstable compost can "burn" roots and cause yellowing and death in sensitive seedlings. Composting essentially puts organic material through the nitrogen stabilization process prior to its use to keep these reactions from occurring in the soil. Partially composted organic matter is still volatile and initiates composting-like reactions when exposed to soils or placed in planter mixes.

- **Operation**

(1) Phytotoxicity can be avoided by using only fully cured compost when it is exposed to growing and living root systems.

(2) Partially cured material should be incorporated in the fall or early spring, thus allowing it to stabilize prior to the planting/growing season.

(3) Compost should be diluted in planter mixes with peat moss, topsoil, aged bark, or other ingredients prior to planting.

(4) Allow planter mixes to cure an additional thirty days after mixing.

(5) As a rule, compost should rarely exceed 40% of a planting mix in potting soil.

Notes

10.8 Noise

Composting equipment can create excessive noise.

- **Siting**

(1) Locate site away from residences.

- **Design**

(1) Incorporate trees and plantings to act as sight and sound barriers.

- **Operation**

(1) Repair or replace noisy equipment.

10.9 Erosion and Sediment Control

The potential exists for erosion to occur on-site and along access roads. The problem of sediment laden run-off entering surface water is a related concern.

- **Siting**

(1) Avoid sites in close proximity to surface waters.

(2) Avoid steep slopes.

(3) Choose a site with moderately permeable soil.

- **Design**

(1) Grade the site properly, preferably with a 1-2 percent grade.

(2) Retain as much vegetation as possible when clearing the site.

(3) Design access and on-site roads properly.

Notes

(4) Use diversion ditches and baled hay to contain run-off.

10.10 DUST

Problems with dust can result from uncontained, dry organic materials and the movement of equipment over unimproved surfaces.

- **Siting**

(1) Provide adequate buffer between the operation and sensitive land uses.

(2) Locate the site downwind of sensitive uses.

- **Design**

(1) Construct access roads with improved surfaces.

- **Operation**

(1) Maintain proper moisture content in the windrows.

(2) Periodically wet unimproved surfaces during episodes of extended dry weather.

10.11 Litter

This is a minor problem at yard waste composting facilities, but one that can create nuisance problems if not properly controlled.

- **Siting**

(1) Provide an adequate buffer zone.

(2) Locate site downwind from sensitive land uses.

- **Design**

(1) Retain perimeter vegetation or design berms to act as wind screen.

- **Operation**

(1) Form yard waste into windrows promptly.

(2) Regularly collect litter from fences or tree line barriers and along roadways.

Notes

10.12 Vectors

Yard waste composting operations do not normally attract vectors, but operators should not disregard the potential.

- **Operation**

(1) Maintain an effective composting process.

(2) Properly store and promptly remove and dispose putrescibles that have been mixed with incoming yard waste.

10.13 Aspergillus Fumigatus

The spores of this fungus, common at composting operations, can produce an allergic response in susceptible individuals, and can cause infections in individuals with weakened immune systems.

- **Operation**

(1) Adequate wetting and minimum disturbance of windrows.

(2) Screen job candidates, at the composting facility, for allergic conditions.

(3) Use of masks or other breathing apparatus.

(4) Only turn compost when there is very little wind.

(5) Keep the compost moist.

Notes

Chapter 11: Compost End Use

Notes

A composting program is more than a solid waste management strategy. A first consideration in planning a composting program is to determine local end uses for the compost. Adequate information on the potential users' requirements for quality and quantity is a mandatory prerequisite for defining the composting method, equipment, and operations necessary to produce a compost meeting the users' demands. As long as high quality, consistent, and stable compost is produced, there should never by any difficulty securing more than adequate demand.

11.1 Characteristics of Compost

Compost is a stable, soil-like material that is an excellent substitute for topsoil, peat moss, and mulches in horticultural and agricultural applications. Yard waste compost is considered to be an excellent conditioner or amendment. Typically, yard waste compost is a very high quality compost with very low to non-measurable concentrations of heavy metals and toxic organic compounds. Yard waste compost requires post-processing in order to have the greatest value. Screening and shredding remove clumps, twigs, branches, and inert contaminants, producing compost consistent in quality and high in value.

Compost's benefits to soil condition include:

- Improved soil aggregation
- Improved water infiltration
- Improved water retention
- Improved soil porosity
- Improved soil aeration
- Decreased soil crusting

In most cases, this compost has limited fertilizer value due to low nitrogen, phosphorus, and potassium content.

11.2 User Types

Compost users can be grouped into four categories: commercial, residential, public agencies, and land reclamation. The specific user types are summarized as follows:

Commercial

- Landscape Contractors
- Nurseries
- Greenhouses
- Turf Farms
- Topsoil Suppliers
- Soil Blenders
- Golf Courses

Residential

- Garden, Lawn and Flower Revegetation

Public Agencies

- Park Maintenance
- Decorative Painting
- Curb Repair
- Backfilling
- Community Gardens

Land Reclamation

- Landfill Cover
- Mined & Derelict Land

Horticultural operations require large, continual supplies of high quality organic material. For landscapers, compost can be substituted for topsoil and peat moss in landscape construction and maintenance. Greenhouses and nurseries may substitute compost for peat moss in potting and planting soil mixes. Turf farms and golf courses may use compost to help establish new soil or as a fine-textured top dressing. Compost can be used effectively as a final cover for landfills and for revegetation of strip-mined or derelict lands. If adequate amounts of free compost are available, public agencies may even expand the use of compost above previous levels constrained by budgetary limits.

11.3 Demand

In order to determine the potential demand for compost, the following information from potential users must be gathered:

- Specifications for organic materials
- Capacity to use compost (both seasonal and annual)

- Shipping and handling requirements
- Potential revenue from sales of compost

Notes

Another important factor is the price of competing materials such as topsoil, peat moss, or other compost products. Most potential users require high quality and consistency. Therefore, maintaining an adequate, stable demand for compost will be greatly dependent on having adequate supplies of a high quality compost at competitive prices. Compost is in highest demand during the spring and early summer months.

Public education also plays a key role in increasing product demand. All potential markets need to be informed of the values and benefits of compost, stressing the value of adding organic matter as well as nutrients to the soil. The fact that the compost is a locally produced resource can be a secondary contribution to steady demand.

11.4 Constraints

11.4.1 User Resistance to Change

In general, it is difficult to capture a market share for a new product, such as compost. If potential users are satisfied with certain existing materials, there is little incentive to change, unless there is a significant price difference. On the other hand, offering compost for free can make potential users suspect that there must be something wrong with it since it is being given away.

Private sector users will be especially resistant to leaving their current supplier if it cannot be demonstrated that a large and stable supply will exist. Overcoming such resistance to change requires efforts focusing on providing accurate product information, user trials, cooperative extension and university testing programs, extensive public education, and possibly demonstration plots in visible areas.

11.4.2 Transportation

Because of compost's relatively low value, it can only be transported cost-effectively within a certain radius. One must be careful to reconcile potential revenue or avoided soil purchase costs against the cost to transport compost to users. Many programs are able to distribute compost primarily through a pickup program, and to charge a fee for delivery that covers costs.

Notes

11.5 Distribution and Marketing Options

There are several bulk compost distribution and marketing options available for yard waste composting programs. Production and distribution of a bagged product is not recommended for yard waste compost. However, local public agencies and departments can obtain compost free of charge utilizing their own equipment to load and transport compost off-site to various job sites or storage areas.

Private operations can be charged on a volume or vehicle basis for bulk material picked up at the compost site or delivered for an additional charge. Also, residents can be encouraged to pick up compost at no charge or at a minimal fee. This third distribution option provides an excellent opportunity to publicize the advantages of composting and resource recycling in general. It also increases public awareness and participation in the collection program, and instills a greater sense of community identity and pride.

A fourth distribution and marketing option is wholesale. Compost can be sold at low cost to soil blenders, topsoil suppliers, and other large-scale suppliers of organic materials. Although this option does not provide maximum revenue or publicity, it requires the least effort on the operator's part to assure that all the compost is distributed for productive use. If compost is to be offered for sale as a soil conditioner or fertilizer, contact the Kansas Department of Agriculture, Agricultural Commodities Assurance Program at (785) 296-3786 or mail to Mills Building, Topeka, KS 66612.

The chart on the following page lists some of the potential markets of compost.

POTENTIAL MARKETS AND COMPOST CHARACTERISTICS

Potential User	**How Used-Desired Characteristics**	**Concerns and Limitations**	**Comments**
Homeowners	Soil amendment, mulch	Aesthetics, nonbiodegradables	
Grounds keepers	Soil amendment, mulch	Aesthetics, handling nonbiodegradables	
Golf courses	Soil amendment, nutrient source	Aesthetics	A somewhat reluctant market
Nurseries (media)	High organics, similar to peat	pH, soluble salts, NH_4^+	Potentially high-paying market but stringent specs
Nurseries (field)	Soil amendment	Varies with species	Requirements less specific than for media
Parks	Soil amendment, Soil extender	Aesthetics, handling	
Landscape Contractor	Soil amendment, Soil extender	Handling	
Agriculture	Nutrient source, possible liming	Nutrient content, availability, and handling	

(*Source: Compost Operations Manual, Minnesota Pollution Control Agency, Groundwater and Solid Waste Division, St. Paul, MN May 1989.*)

Notes

Chapter 12: Economics

Notes

In many areas of the United States the cost of yard waste composting is less than the traditional means of disposal. Program benefits are primarily measured in terms of avoided disposal cost based on the amount of material diverted from landfill or incineration. For municipalities and some businesses the production of compost results in additional savings by reducing soil purchases. Some programs also generate revenue from compost sales.

Program planning should include the following economic assessments:

- Evaluating program capital and operating cost
- Estimating avoided disposal and soil purchase costs
- Determining if and what fee will be charged to end users
- Assessing the overall costs and benefits

This chapter focuses on the major operational components of yard waste composting; discussing major cost variables, common equipment, personnel, operating efficiency, and some reported costs for operating programs. The worksheets in Appendices B-1 through B-7 provide the basis for estimating costs and subsequent development of a cost accounting system. Site development, education, and startup costs are not reviewed. It should also be noted that a source separated or municipal solid waste compost site will have significantly higher costs.

Costs may vary from program to program due to such factors as the scale of operations, material input, labor costs, available equipment, and the technology used. Additionally, for many municipalities, yard waste program costs are not a "line item" in budgets, but are blended into overall department costs. When equipment and personnel are used for various projects or tasks within the public works department, it can be difficult to track actual costs directly. Consequently, the costs reported in this document should serve only as a guide.

12.1 Budgeting and Cost Accounting

Program operations can be divided into five components: collection, preprocessing, composting, post-processing, and end use. For each component, the key cost variables to be recognized are:

Notes

- The quantity of material,
- The amount of labor required, and
- The operating efficiency of the equipment used.

12.2 Costs - Capital and Operating

12.2.1 Collection Operations

Yard waste collection costs represent the largest single cost component of the total program. If a region, county, or municipality already provides solid waste collection, fewer additional costs will be incurred.
Appendix B-1 presents a format for estimating collection costs. Because collection costs may already be incurred through either municipal or private collection of solid waste, the objective should be to calculate the change in costs due to the shift from disposal to composting.

The most common collection process uses a rear or side loading compactor truck, one driver, and two collectors. Collection efficiency can be expected to range from two to three tons per paid crew hour. The efficiency is dependent on such variables as distance to the compost site, participation rates, number of bags per stop, street traffic, collector experience, bulk density of leaves, and weight per bag.

A wide range of total collection costs have been reported, including:

- Seattle, Washington, $3/month (1994) (BioCycle, 1994)
- Jacksonville, Florida $25/ton (1993) (BioCycle, 1994)
- Bristol, Connecticut $55/ton (1988) (E&A Environmental Consultants, 1989)
- Naperville, Illinois $.50/bag (BioCycle, 1994)

Capital and operating costs for a 20 cubic yard rear loading packer average $100,000 and $15/hour, respectively.

12.2.2 Preprocessing Operations

If yard waste is collected in bags, the yard waste must be opened before composting in order to allow for proper oxygenation and moisture addition.

Non-degradable bags also require the removal of the plastic which can be very labor intensive. Degradable bags can be broken with the turning equipment if it has a shredding action. In a system using a front-end loader, the bags will need to be manually emptied.

Notes

Woody material should be shredded to increase surface area and accelerate decomposition. Shredding produces a relatively homogenized mixture of yard waste. Included in the cost calculation for this component are process watering (for MSW composting) and windrow formation. Appendix B-2 presents a preprocessing cost estimating format. A common preprocessing arrangement for a large yard waste operation is a tub mill grinder equipped with a grapple and knuckle boom, a front-end loader, two dump trucks, and a water truck or fire hydrant. Crew requirements for such a system are two heavy equipment operators and two or three drivers/laborers.

Preprocessing efficiency can range from 15 to 20 tons/paid crew hour, dependent primarily on actual throughput of the shredding/grinding equipment. Costs for preprocessing are not usually listed separately from overall composting costs. However, the Bristol, Connecticut program has estimated preprocessing at approximately $15 per ton (including amortized capital cost for a tub mill grinder). Overhead and maintenance costs for a tub mill grinder are comparatively high because the hammers require frequent maintenance.

12.2.3 Composting Operations

Costs associated with composting include windrow turning, monitoring, and curing pile formation. Appendix B-3 presents a method for estimating costs for this phase of a program. Two common arrangements for windrow turning/aeration monitoring are:

- A front-end loader with one equipment operator

- A windrow turning machine with one equipment operator

Average composting efficiency can range from 30 to 90 tons per paid crew hour for a front-end loader depending on the bulk density of the compost, operator skill, distance between windrows, and weather conditions. A self-propelled, flail-type windrow turning machine can process 2,000 to 3,000 tons per paid crew hour, dependent on similar variables. Capital and operating cost for this type of machine are $125,000 and $25 per hour, respectively. Such equipment can generally be justified only for larger programs.

Notes

Monitoring requires gathering scheduled temperature records and moisture content during active phases of decomposition. Less frequent temperature readings may be taken as composting slows to mesophilic condition.

Curing pile formation generally entails use of one front-end loader and two dump trucks with associated labor. This method moves 90 to 100 tons per paid crew hour.

Total costs for composting are highly dependent on the total number and frequency of turnings. Composting costs which have been reported include:

- Lincoln, Nebraska Approximate $10/ton (1989) (Hanlon, 1989)
- Jacksonville, Florida $19.76/ton (1993) (BioCycle, 1994)
- Woodbury, Minnesota $15/ton (1987) (Taylor & Kashmanian, 1989)
- Newton, Massachusetts $4/ton (1987) (Simpson, 1988)
- Urbana, Illinois $4/ton (1988) (Darling, 1989)

12.2.4 Post-Processing Operations

Post-processing entails shredding and screening to break up clumps and remove contaminants, This step is needed to produc a uniform, high-quality soil amendment. A common arrangement for yard waste compost in post-processing uses a shredder/screener, a front-end loader, and possibly a dump truck for moving the compost. The labor requirement is one heavy equipment operator. Appendix B-4 can be used to calculate costs. Shredder/screener equipment can be either purchased or rented. A number of programs rent equipment because of the relatively infrequent schedule for postprocessing. An alternative is for several programs to jointly purchase, maintain, and use one machine. Large shredder/screeners are available that process up to 200 tons per hour. However, a more common size for municipal scale programs is 25 to 35 tons per paid crew hour. Capital and operating costs for such a unit are $70,000 and $15 per hour, respectively. (See Appendix B-4)

12.3 Distribution

Yard waste compost is most commonly distributed in bulk. Distribution of a bagged compost product requires much more careful market analysis and persistent marketing efforts. Because the demand for bulk compost is normally equal to or greater than the supply, most communities decide not to market a bagged product.

Compost may be distributed in three ways:

- Used by parks and public works departments
- Sold or given away to residents and private enterprises
- Sold or given away to soil blenders, compost brokers, or topsoil suppliers

Notes

Many programs will depend primarily on the first two options. The public sector use will generate avoided soil purchase costs that should be factored into a cost-benefit analysis. Compost can be sold to residents and the private sector at a fee which can be used to cover some of the program costs. Revenue generated from sales must be part of a cost-benefit analysis. Greenwich, Connecticut sells compost for $6 per yard. Woodbury, Minnesota, avoids land costs by exchanging compost for use of a nursery's land. East Tawas, Minnesota, uses all its compost in parks and public works projects. Seattle, Washington, charges $7.50 to $12.50 per yard.

When compost is given away or sold at the compost site, distribution costs will be limited to site monitoring and possibly operation of a bucket loader for loading material. If compost is given away or sold at several distribution points, or delivered to customers, additional costs will be incurred for transportation. Distribution costs can be calculated using Appendix B-5.

12.4 Financing Alternatives

Existing composting programs typically do not report the entire operations capital or operating and maintenance costs. The costing methods differ for each community and are dependent on the following variables: local labor rates, type of equipment rates, equipment maintenance, insurance, fuel and financing mechanisms.

Accurate and reliable composting operations cost information, reflecting existing programs is difficult to obtain. For example, many Public Works Directors determine labor and equipment rates, but do not calculate specific maintenance, insurance on debt service expense associated with composting effort. A 1986 limited survey of annual collection costs of existing collection operations in California, New Jersey and Minnesota show cost ranging from $9 per ton of yard waste collected using a packer truck to $80 per ton using a vacuum collection vehicle. This cost range includes the use of new equipment, municipal labor and equipment depreciation. Preliminary capital

Notes

investment and annual cost estimates for individual yard waste collection programs were not presented.

Constraints on the budgets of many local governments have increased dramatically in recent years. This trend has been compounded by the rising cost of solid waste collection and disposal, including the costs of current system and the added costs of closures, post-closure, and remediation. Many communities, therefore, are looking for new sources of funding yard waste composting programs through a variety of tax and revenue options.

12.4.1 Tax Financing - Property

Traditionally, funding for community solid waste systems comes from a general fund, whose primary source of revenue is the property tax. A growing trend toward tax reform in recent years has led many communities to seek alternative taxes to fund solid waste programs.

Many communities have successfully used a portion of property tax to support the solid waste management system. This tax is easy to administer since no separate billing or collection system is needed and payment is virtually guaranteed (many citizens prefer this method of financing since the tax is deductible on federal and state income tax returns). The primary disadvantage is that solid waste is often considered a low-priority item and must compete with other municipal budget items. Second, since solid waste operating costs often are not broken out from other costs, there is less incentive for efficient operation of the system. If cost savings are instituted, the savings usually accrue to the general fund rather than the solid waste system.

12.4.2 User Fees

User fees can be an equitable means of funding yard waste composting projects if properly administered. The community can establish fees on the basis of actual costs of collection, processing and marketing of the compost material. The user fee can be assessed at a uniform or variable rate, depending on the amount and kind of service provided.

Uniform Fees

A straight user charge allocates an equal share of the costs to all users within a service-level group. This type of user charge can be collected by adding a separate yard waste collection charge to a periodic utility bill or the yearly property tax bill, or through a separate billing system. To avoid added overhead costs and to facilitate collection of bills, it is usually preferable to attach the charge to an already existing billing system. This type of user charge is efficient and the least costly to administer.

Notes

Variable Fees

A progressive user charge represents an attempt to correlate costs and service by charging the resident according to the amount of yard waste generated. The assessment can be calculated in two ways: 1) a charge for each container collected, or 2) a minimum charge that would cover collection of a certain number of containers plus an extra charge for each additional container.

Controlling variable user fees so that customers are billed only for the containers they are using and collectors know how many containers are supposed to be collected from each customer can be difficult. An increasing number of communities are turning to this kind of system; however, a variety of methods for identifying, collecting, and charging for yard waste container pickup are being used throughout the country. These include using specially marked containers or providing, for a fee, either special bags or special container stickers and tags.

One problem that is often raised concerning user fees is that residents charged on a volume or container basis might have a tendency to overfill their containers or engage in illegal dumping when they have more yard waste than will fit in the container. This could result in loose yard waste, higher street cleaning costs, and public dissatisfaction. Communities can approach this problem by providing standardized containers to households or selling prepaid yard waste tags (available from local grocery and convenience stores). Yard waste that is not in a provided container, or not tagged for pickup is clearly identifiable as being in violation.

Traditionally, user charges have seldom covered the total cost of operating a yard waste composting program. Yard waste services usually are paid partially out of funds raised from property taxes. As a result, the public often becomes accustomed to a nominal service charge and some city officials feel the public would raise strong objections to a service charge that actually reflects total operating costs. Decision makers can take advantage of the planning process in this instance by using public education and involvement programs to discuss increased waste generation, shrinking disposal capacity, and rising system costs. The public's increased awareness of composting issues coupled with a sense of their own role in the decision making process,

Notes

may provide the opportunity to adjust user fees to reflect the real cost of providing yard waste composting.

User fees foster citizen awareness of yard waste collection, processing, and disposal costs and provide an impetus for more efficient consumer behavior. User fees are an excellent means of placing explicit costs on each household as an incentive to reduce waste generation and encourage backyard composting. Primary problems with user charges are billing, difficulties in administration, and the fact that if they truly reflect costs, they may be too high for low-income or fixed-income persons.

12.4.3 Revenues From Composting Program

Financial planning for a composting system should account for any operating revenues that may be generated if the compost is sold, as well as any cost savings realized by not landfilling wastes that are composted. It is important to recognize that much of what composting does is help to avoid disposal costs. In a full cost accounting system these savings will showup as significant. Benefits not only include monetary factors, but environmental impacts, such as land conservation, revitalization of soils, and saving valuable landfill space.

Appendix A-1: Material Delivery Data Sheet

Appendix A-1: Material Delivery Data Sheet

Month ________________ **Year** ________

DATE	Vehicle No. _________ Type _______________ Cap. Cu. Yd.	Vehicle No. _________ Type _______________ Cap. Cu. Yd.	Vehicle No. _________ Type _______________ Cap. Cu. Yd.	Vehicle No. _________ Type _______________ Cap. Cu. Yd.	**TOTAL**
	Loads CY/Tons	Loads CY/Tons	Loads CY/Tons	Loads CY/Tons	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

Appendix A-1: Material Delivery Data Sheet

Month ________________ **Year** ________					
DATE	Vehicle No. _________ Type _______________ Cap. Cu. Yd.	Vehicle No. _________ Type _______________ Cap. Cu. Yd.	Vehicle No. _________ Type _______________ Cap. Cu. Yd.	Vehicle No. _________ Type _______________ Cap. Cu. Yd.	**TOTAL**
	Loads CY/Tons	Loads CY/Tons	Loads CY/Tons	Loads CY/Tons	
17					
18					
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
Total					

(Source: New Jersey Office of Recycling)

Appendix A-2: Windrow Temperature Monitoring Data Sheet

Appendix A-2: Windrow Temperature Monitoring Data Sheet

Date collected by: ______________________________ Year: ____________ Month: ____________

Weather Information (Sunny, rain, etc.) ____

Wind direction (from Northeast, South, etc.) ____

Air Temperature: °F ________ **Time of day:** ____________________

Site Observation Comments (Water ponding, dust, etc.) _________________________________

____

____

Windrow Moisture ("Hand squeeze" test observation) circle item:

	Needs moisture	Satisfactory	Excess
Odor (circle item):	None	Minimal	Strong

Windrow Temperature Measurement Location	**Temperature Observation ^{0}F**									
	Windrow Observation (See Sketch Below)									

Diagram

Action Taken (turned windrow, graded etc.): ____

____

Source: Connecticut DEP, 1989.

Appendix A-3: Windrow Temperature Monitoring Data Sheet

Appendix A-3: Sample Windrow Temperature Data Sheet

Data collected by: K. C. COMPOST Year: 1989 Month: FEB.

Weather Information (Sunny, rain, etc.) RAIN

Wind direction (from Northeast, South, etc.) N.E.

Air Temperature: °F 36°F **Time of day:** 10 a.m.

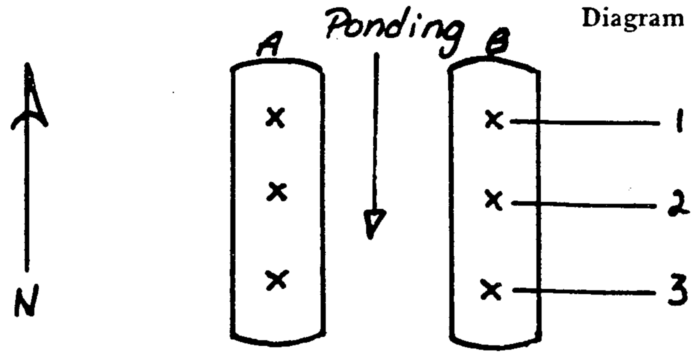
Site Observation Comments (Water ponding, dust, etc.) wet, cold, windy. Ponding between windrows A and B.

Windrow Moisture ("Hand squeeze" test observation) *circle item:* Needs moisture [✓ Satisfactory] Excess

Odor *(circle item):* [✓ None] Minimal Strong

Windrow temperature measurement location:	Temperature Observation, °F								
	Windrow Observation (See Sketch Below)								
	A	B							
1	115	106							
2	120	102							
3	118	110							

Diagram



Actions Taken (turned windrow, graded, etc.): Instructed operator to regrade between A and B.

(Source: Connecticut DEP, 1989)

Appendix B-1: Economic Worksheets-Collection Costs

Appendix B-1: Economic Worksheets-Collection Costs

A. **Capital Cost:**

In order to determine how much of capital cost should be charged to collection program, capital cost is multiplied by an annual depreciation factor (ADF), see Appendix B-7, and prorated based on percent of total equipment year dedicated to collection program.

1. Compactor Trucks:
(________units) * ($__________) * (____________ADF) * (_______________%) = $_______________________

B. **Equipment Cost:**
Based on the estimated quantity of material to be collected, and an average crew efficiency, the required hours are multiplied by either hourly Overhead and Maintenance (O&M) costs or rental cost.

1. Compactor Trucks:
(_______________tons). (__________________tons/hr) * ($____________/hr) = $_______________

C. **Labor Cost:**
The required hours have been calculated above from quantity of yard waste times equipment efficiency.
1. Drivers:
(_______________persons) * (________________hrs) * ($______________/hr) = $______________
2. Collectors:
(_______________persons) * (________________hrs) * ($______________/hr) = $______________

D. **Degradable Bag Cost (if used):**
Assume that on average each household will require 2 bags per week.
(________________hsehlds) * (_____________wks) * 2 * (0._______________/bag) = $_____________

E. **Total Collection Cost:**
Sum of above costs. = $ _____________

F. **Net Collection Cost**

By subtracting former or current collection cost from total degradable bag collection cost the impact of separate collection for composting can be measured. A positive number indicates increased collection costs, and a negative number indicates reduced costs.

1. Collection Cost for Composting: $______________

2. Current or Former Collection Cost:
(_____________________$/ton) * (_________________tons) $______________

3. Change in Collection Cost: = $______________

SOURCE: **Leaf and Yard Waste Composting Manual**, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, MA.

Appendix B-2: Economic Worksheets-Preprocessing Costs

Appendix B-2: Economic Worksheets - Preprocessing Costs

A: Capital Cost:

In order to determine the amount of capital cost to be charged to the preprocessing component, capital cost is multiplied by an annual depreciation factor (ADF), see Appendix B-7, and prorated based on percent of total equipment year dedicated to preprocessing component.

1. Tub Mill Grinder:
(________________units) * ($__________) * (________________ADF) * (________%) = $ __________
2. Front End Loader:
(________________units) * ($__________) * (________________ADF) * (________%) = $ __________
3. Dump Trucks:
(________________units) * ($__________) * (________________ADF) * (________%) = $ __________
4. Water Truck:
(________________units) * ($__________) * (________________ADF) * (________%) = $ __________
5. Fire Hydrant & Hose:
(________________units) * ($__________) * (________________ADF) * (________%) = $ __________

B. **Equipment Cost:**

Based on the estimated quantity of material to be preprocessed, and an average crew efficiency, the required hours are multiplied by either hourly Overhead and Maintenance (O&M) costs or rental cost.

1. Tub Mill Grinder:
(______________tons). (______________tons/hr) * ($_______________/hr) = $ ___________
2. Front End Loader:
(______________tons). (______________tons/hr) * ($_______________/hr) = $ ___________
3. Dump Trucks:
(______________tons). (______________tons/hr) * ($_______________/hr) = $ ___________
4. Water Trucks:
(______________tons). (______________tons/hr) * ($_______________/hr) = $ ___________

C. **Labor Cost:**

The required hours have been calculated above from quantity of yard waste times equipment efficiency.

1. Heavy Equipment Operators:

(_______________persons) * (__________hrs) * ($___________/hr) = $ _____________

2. Drivers:

(_______________persons) * (__________hrs) * ($___________/hr) = $ _____________

3. Workers:

(_______________persons) * (__________hrs) * ($___________/hr) = $ _____________

D. **Total Preprocessing Cost:**

Sum of above costs = $_________________

Source: **Leaf and Yard Waste Composting Manual**, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, MA.

Appendix B-3: Economic Worksheets-Composting Operations Cost

Appendix B-3: Economic Worksheets-Composting Operations Cost

A. Capital Cost:

In order to determine the amount of capital cost that should be charged to composting component, capital cost is multiplied by an annual depreciation factor (ADF), see Appendix B-7, and prorated based on percent of total equipment year dedicated to composting component.

1. Front End Loader:

(______________units) * ($____________) * (___________________ ADF) * (_________%) = $ ____________

2. Windrow Turning Machine:

(______________units) * ($____________) * (___________________ ADF) * (_________%) = $ ____________

3. Thermometers:

(______________units) * ($____________) * (___________________ ADF) * (_________%) = $ ____________

4. Dump Trucks (for curing pile formation):

(______________units) * ($____________) * (___________________ ADF) * (_________%) = $ ____________

B. Equipment Cost:

Based on the estimated quantity of material to be composted, and an average crew efficiency, per turning/aerating, the required hours are multiplied by number of turnings and either hourly Overhead and Maintenance (O&M) cost or rental cost.

1. Front End Loader:

(__________tons). (____________________tons/hr) * ($_____________ /hr) = $_____________

2. Windrow Turning Machine:

(__________tons). (____________________tons/hr) * ($_____________ /hr) = $_____________

3. Dump Trucks (for curing pile formation):

(__________tons). (____________________tons/hr) * ($_____________ /hr) = $_____________

C. Labor Cost:

The required hours have been calculated above from quantity of yard waste times equipment efficiency.

1. Heavy Equipment Operators:

(__________persons) * (_______________hrs) * ($____________ /hr) = $______________

2. Drivers:

(__________persons) * (_______________hrs) * ($____________ /hr) = $______________

D. **Monitoring Cost:**

Based on the linear yardage of compost windrows and an average monitoring rate, the required hours are multiplied by number of monitorings and either hourly O&M cost or rental costs.

1. Monitors:

(_____________persons). (______________yards/hr) * (___________monitoring) * ($ _______/hr) = $_____________

E. **Total Composting Cost:**

Sum of above costs = $_________________

Source: **Leaf and Yard Waste Composting Manual**, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, MA.

Appendix B-4: Economic Worksheets-Post-Processing Costs

Appendix B-4: Economic Worksheets-Post-Processing Costs

A. Capital Cost:

In order to determine the amount of capital cost that should be charged to post-processing component, capital cost is multiplied by an annual depreciation factor (ADF), see Appendix B-7, and prorated based on percent of total equipment year dedicated to post-processing component.

1. Front End Loader:
(____________units) * ($___________) * (____________________ADF) * (_________%) = $______________
2. Shredder/Screen:
(____________units) * ($___________) * (____________________ADF) * (_________%) = $______________
3. Dump Trucks (for stockpiling compost):
(____________units) * ($___________) * (____________________ADF) * (_________%) = $______________

B. Equipment Cost:

Based on the estimated quantity of material to be post-processed, and an average crew efficiency, the required hours are multiplied by number of turnings and either hourly Overhead and Maintenance (O&M) cost or rental cost.

1. Front End Loader:
(_____________tons). (_________________tons/hr) * ($__________________/hr) = $______________
2. Shredder/Screener:
(_____________tons). (_________________tons/hr) * ($__________________/hr) = $______________
3. Dump Trucks (for stockpiling compost):
(_____________tons). (_________________tons/hr) * ($__________________/hr) = $______________

C. Labor Cost:

The required hours have been calculated above from quantity of yard waste times equipment efficiency.

1. Heavy Equipment Operators:
(________________persons) * (______________hrs) * ($___________________/hr) = $______________
2. Drivers:
(________________persons) * (______________hrs) * ($___________________/hr) = $______________

D. Total Postprocessing Cost:

Sum of above costs. $________________

Source: **<u>Leaf and Yard Waste Composting Manual</u>**, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environm ' Consultants, Inc., Stoughton, MA.

Appendix B-5: Economic Worksheets-Distribution Costs

Appendix B-5: Economic Worksheets-Distribution Costs

A. Capital Cost:

In order to determine the amount of capital cost that should be charged to distribution component, capital cost is multiplied by an annual depreciation factor (ADF), see Appendix B-7, and prorated based on percent of total equipment year dedicated to distribution component.

1. Front End Loader:
(__________units) * ($__________) * (__________________ADF) * (________%) = $____________
2. Dump Trucks (for stockpiling compost):
(__________units) * ($__________) * (__________________ADF) * (________%) = $____________

B. Equipment Cost:

Based on the estimated quantity of material to be distributed, and an average crew efficiency (delivery time for certain load size), the required hours are multiplied by hourly Overhead and Maintenance (O&M) cost or rental cost.

1. Front End Loader:
(___________tons). (________________tons/hr) * ($________________/hr) = $____________
2. Dump Trucks (for delivering compost):
(___________tons). (________________tons/hr) * ($________________/hr) = $____________

C. Labor Cost:

The required hours have been calculated above from quantity of yard waste times equipment efficiency.

1. Site Monitor:
(______________persons) * (____________hrs) * ($________________/hr) = $____________
2. Heavy Equipment Operators:
(______________persons) * (____________hrs) * ($________________/hr) = $____________
3. Drivers:
(______________persons) * (____________hrs) * ($________________/hr) = $____________

D. Total Distribution Cost:

Sum of above costs. $________________

Source: **<u>Leaf and Yard Waste Composting Manual</u>**, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, MA.

Appendix B-6: Economic Worksheets-Total Program Cost-Benefit Summary

Appendix B-6: Economic Worksheets-Total Program Cost-Benefit Summary

A. Avoided Disposal Cost

1. Quantity of Yard Waste Collection ____________________ tons
2. Current Disposal Cost * $ ____________________
3. Avoided Disposal Cost = $ ____________________

B. Avoided Soil Purchase

1. Current Soil & Amendment Purchases ____________________ cubic yards
2. Average Cost per Cubic Yard * $ ____________________
3. Expenditures for Soils & Amendments = $ ____________________
4. Percent Substitution by Compost * ____________________%
5. Avoided Soil Purchase Cost = $ ____________________

C. Simple Cost-Benefit Calculation

1. Avoided Disposal Cost $ ____________________
2. Avoided Soil Purchase Cost + $ ____________________
3. Total Compost Program Cost + $ ____________________
   (Net Collection Cost plus other Component Costs)
4. Program Net Cost/Benefit = $ ____________________

Source: **Leaf and Yard Waste Composting Manual**, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, MA.

Appendix B-7: Economic Worksheets-Calculating Annual Straight Line Depreciation

Appendix B-7: Economic Worksheets-Calculating Annual Straight Line Depreciation

Annual Depreciation:

$$= (c - s)/ n$$

where: c = purchase cost
s = salvage value
n = service life in years

Two other methods that can be used to calculate the annual cost of purchasing equipment are:

Capital Recovery Factor:

$$= \frac{i(1 + i)n}{(1 + i)n - 1}$$

where: i = interest or discount rate
n = number of years

Annual Interest:

$$= i(c + s)/2$$

where: i = annual interest rate
c = purchase cost
s = salvage value

Source: **Leaf and Yard Waste Composting Manual**, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, MA.

Appendix C: Suppliers of Thermometers

Appendix C: Suppliers of Thermometers

The thermometer is an important piece of monitoring equipment to purchase for any composting operation. The temperature of the piles indicates when those piles should be turned (below 100 °F or above 140 °F) in order to maintain the optimum environment for microbial activity. Specifications for ordering a compost thermometer includes the following:

1. A 36-inch long Pointed stem
2. A temperature range of 0°-200°F
3. A 3 or 5-inch diameter dial
4. Stainless steel (it is stronger than aluminum)
5. Plastic or acrylic lenses (optional, not necessary)

The following are companies supplying thermometers fitting the above stated specifications. This is only a partial listing and by providing it, the Department of Health and Environment is not endorsing these companies over any others.

1. Fluid Technology Corporation
1631 Northeast 55 Avenue
Des Moines, IA 50313
(515) 263-9210
Model: A With 3 inch dial
Cost: $61.60 + shipping
Availability: 10 working days

2. Omega Engineering, Inc.
One Omega Drive
Box 4047
Stanford, CT 06907
(203) 359-1660
Model: S With 3 inch Dial
Cost: $81.50 + shipping
Availability: 3-5 days

3. Meriden Cooper Corporation
112 Golden State Park
Box 692
Meriden, CT 06450
(203) 237-8448
Model: Tel-Tru GT 300 R
With 3 inch dial
Cost: $65.90 + shipping
Availability: 3-5 days

4. Reotemp
11568 Sorrento Valley Road
Suite 10
San Diego, CA 9212
(800) 648-7737
Model: A36P
Cost $86.50 + shipping
Availability: 3-5 days

Note: All prices verified 02/98.

Source: **Leaf and Yard Waste Composting Manual**, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, MA.

Appendix D-1: Compost Operation Equipment List

Appendix D-1: Compost Operation Equipment List

	Description	Cost
A.	**Front end loaders:**	
(1)	90 hp with 1.75 cu yd bucket	$ 55,000
(2)	115 hp with 3 cu yd bucket	$ 70,000
(3)	155 hp tractor (without bucket)	$ 80,000
	(a) 3 cu yd bucket	$ 4,800
	(b) 7 cu yd wood chip and snow bucket	$ 7,400
	(c) Quick attachment system	$ 3,900
(4)	82 hp tractor (without bucket)	$ 60,000
	(a) Lease with 1.6 cu yd bucket	$ 2,600/month
(5)	123 hp tractor (without bucket)	$ 87,000
	(a) Lease with 2.4 cu yd bucket	$ 3,600/month
(6)	158 hp tractor (without bucket)	$111,000
	(a) Lease with 3.0 cu yd bucket	$ 4,600/month
(Note: Based on experience in Springfield, MA, a 3 cu yd loader can turn approximately 180 cu yd per hour with each load lifted high and allowed to cascade into a new windrow).		
B.	**Specialized aerating and turning equipment:**	
(1)	Flail-type; self propelled; turns windrows up to 7 ft. high and 18 ft. wide at a rate of up to 3,000 tons per hour; 360 hp; not easily transported between sites (10'6" wide and 14'6" high on low bed trailer)	$160,000
(2)	Auger type; mounted on a tractor that can be used with numerous options attachments; turns windrows up 6 ft. high and 10 ft. wide at a rate of up to 3,000 tons per hour; engine options of 177 to 225 hp; not convenient for long distance transport; can be driven on road at a maximum speed of 20 mi/hr	$180,000
(3)	Flail-type; powered by 177 hp engine while attached to front loader (loader not included); turns windrows up to 5 to 6 ft. high and 14 ft. wide at a rate of up to 800 tons per hour; can be loaded on a flat bed truck with a front end loader equipped with a quick catch system	$ 65,000

Appendix D-1: Compost Operation Equipment List

Description		Cost
(4)	Flail-type; attaches to a large farm type tractor with a three point hitch and power-take-off (The tractor should have 100 to 225 hp and a hydrostatic transmission or a creeper transmission with 2 or 3 speeds under 1/3 mi/hr with power-take-off at 1,000 rpm); turns windrows 5 to 6 ft. high and 14 ft. wide at a rate of up to 600 tons per hour; special wheels for over the road transport.	$ 30,000
C.	**Separating and shredding equipment:**	
(1)	25 cu yd/hr; 18 hp gasoline engine	$ 17,000
(2)	75 cu yd/hr; 55 hp diesel engine	$ 40,000
(3)	200 cu yd/hr; 110 hp diesel engine	$ 91,000

Source: Connecticut DEP, 1989.

Appendix D-2 Compost Equipment Described

Front-End Loaders

Low-tech composting requires only a front-end loader for layering and turning the piles scoop-by-scoop. With a skid-steer loader with an oversized bucket, one operator can easily manage ten thousand cubic yards of incoming material per year. The capacity of a loader is related to the size of the bucket, the lift height of the loader, and the cycle time of the machine. Operating capacity can be calculated by multiplying bucket size by the cycle time per hour, both figures which can be provided by the dealer. If possible, secure a self-leveling loader that automatically returns the bucket to ground level.

A loader rated for two cubic yards of gravel should be able to handle a four cubic yard, light-material bucket. Cycle time refers to the time it takes the loader to pick up the scoop, move it to the next windrow, and dump the load. Given a thirty-second cycle time, a four cubic yard loader should be able to move 480 cubic yards per hour. A typical loader operator should provide a net of six full running hours during an eight-hour work day. The other time is for maintenance, fueling, breaks, and cleaning. A typical loader is rated to operate at 172 hours per month, but actual operations of 130 hours per month are more realistic.

Once the composting option is chosen, efforts should be made to find users who will accept the compost rough, which means "unshredded and unscreened." With a "loader only" composting process, further composting is made difficult because grass and leaves tend to mat and compact in clumps. If the material is to be used in a planter mix or for use other than direct incorporation into the soil, these mats and clumps must be broken up, and the only way to do this acceptably is by mixing or shredding.

Failure of the materials to darken and heat up indicates that the compost should be more thoroughly mixed or shredded. This problem may occur when the percentage of leaves is high or if original moisture mixing was poor. If a shredder is not available, the material can be broken up using a manure spreader with flails or beaters at the discharge end. Corn or silage cutters tend to clog as most composts at this point are too wet and sticky to blow or chop.

Mixers

Mixing can be done with compost turning equipment. Mixers are characterized by windrow straddling, meaning that the pile is turned and mixed as the machine moves down the windrow.

Compost Windrow Turners

Compost windrow turning machines like the Scarab or the Wildcat have had proven success in many communities. An advantage of these machines is that they aerate the material thoroughly, compost evenly, turn more yards per hour than front-end loaders, and are suited to high-volume operations. One disadvantage of composters and shredders is that they break glass and do not remove it. With a shredder system, the pile is shredded only once. With a windrow turner, the pile is turned at least five to ten times, sometimes up to thirty times. The compost produced from windrow turners is usually superior in texture due to this repeated pulverization.

Windrow turners require levels surfaces. Some models are difficult to move from site to site, often requiring over width permits on specialized equipment-moving trailers. The site will still need a loader to form and break down windrows. On all large equipment, the operators must be qualified to perform a great deal of maintenance and to perform repairs in the field.

Watering Equipment

Watering can be done with garden hoses, preferably with single post, directional sprayers that are easy to move and align. Of the two types of post sprayers, one sprays at approximately a thirty degree angle, the other at approximately sixty degrees. Both should be available at the site depending on the height of the pile being watered. The water source for a good composting operation should provide a minimum of 30 gallons per minute to supply six hoses at five gallons per minute each. Single post sprayers are superior to soaker hoses because they are easier to handle and control direction of the spray. On and off valves at the end of each hose make it easier to move hoses and adjust flow rate.

If city water is not available, digging a shallow well might be practical. No surface water runoff should flow back into a water supply. Water might have to be trucked in if necessary. Water trucks, however, tend to discharge water at a rapid rate and often cause runoff. If the truck has a power-take-off (PTO) driven pump with a controllable side discharge system, water can be acceptably brought in from off site.

Shredders

Two basic types of shredders on the market are crumblers and hammermills. Crumblers, have few wear points, since their action is caused by a fast moving cleated belt that crumbles the compost against steel fingers. Hammermills, impact the compost against hammers that rotate on a fast turning shaft against spring-loaded teeth. A critical concern is the ability of the feeder hopper to handle the size of the loader bucket and to keep the compost from "bridging" or clogging due to high moisture.

While a certain logic would suggest an initial shredding before composting to reduce particle size, it is best performed following the first six to eight week period of watering, blending, and turning. The advantages of waiting until after primary decomposition to shred are several. They include hand removal of debris, especially bottles, prior to grinding. The material has about one half the volume of the raw waste, it is drier and crumbles easier, and it blends better after this initial composting phase. The improvement in quality after shredding is significant and some sort of particle size reduction should be a component of most composting operations where the material is being use in applications other than farmland.

Shredding at this phase of decomposition will provide a more complete mixing of the material. Shredding thoroughly blends the dry with the wet spots and fully aerates the pile. Following this shredding, the pile will heat rapidly and cure in an additional four to six weeks. Shredding in the fall will ensure that the piles will have sufficient time to continue curing during the winter, producing a more marketable compost come spring.

Some shredders have a trash discharge conveyor that is effective in improving compost quality by reducing contaminants. Many shredders come with screeners that can be used effectively if the material was previously dried and cured. Wet compost will clog most shredders and screens. Compost should be shredded and homogenized prior to the screening phase. For a low-tech system, screening should wait at least thirty days following shredding to allow the pile to further cure and dry. The drier the compost, the easier it will be to shred and screen. Compost is a nuisance to screen and shred compared to topsoil, peat, or other commodities. It has a sticky and unpredictable nature. To determine the raw compost shredding capacity, note the rated capacity of the shredder for topsoil and divide this number by eighty (80) percent.

Screens

Screening is recommended if considerable plastic, rock, stick, or debris must be removed. Screening using #1 (one inch) mesh is adequate for most uses. Number 2 (half inch) mesh will provide a high quality gardening product or planter mix. Most fine potting soils are screened at #2 or #3 (three eights inch) mesh, and some lawn top dressings are screened at #4 (one quarter inch) mesh. Mesh size is related to the numbers openings per inch in the screen cloth. Rotary or trommel screens are preferred for compost since they often have brushes for self-cleaning. Inclined deck screens are fine for dry composts and topsoil, but tend to "blind" (clog) at moisture contents over 45%. Screening at #4 mesh requires a compost that is almost dusty.

Many communities may be able to rent or contract for compost pile management from a local topsoil company. Shredding should not cost more than two dollars per cubic yard. Once numerous communities begin composting, the sharing of equipment can lead to cost savings.

Tub Grinders

Tub grinders have an intake chamber that looks like a large washtub sitting on a platform. Loaded with a front-end loader, a tub grinder can take an entire large bale of hay at once. The tub rotates, moving materials across a set of hammermills that shear the material. The size-reduced material is forced through a screen onto a conveyor belt leading to standing piles or to a receiving vehicle. Tub grinders come in several models with a variety of power sources and have been successfully used in operations that handle a large quantity of brush, small trees, and even wooden pallets. Hammermills and grinders require frequent replacement of wear items. Considerable down time can be expected for maintenance with all shredders.

Chippers

Woody debris, brush, and limbs take up a great deal of space. Chippers readily reduce such material to a more homogeneous consistency that can be used for foot paths in parks, around plants, and as decorative landscaping. Municipalities and utilities frequently use hand-fed portable chippers to reduce the volume of brush at the curb, feeding chips directly into a pickup or dump truck. Chipper blades range from 12 - 16 inches; heavy duty blades can handle some small pieces of metal without damaging the machine.

Forced Aeration Equipment

Methods have been developed to increase the availability of air to the pile interior though the use of perforated plastic drain pipes. One method is to place a series of heavy duty, high density polyethylene or polyvinyl chloride perforated pipes on a slant every six feet or so along the windrow length, lying approximately at a 45 degree angle from a position low on one side of the pile towards the top of the other side. Forced aeration equipment typically utilizes a network of flexible plastic pipe that is laid prior to constructing the windrows. One third horsepower blowers or pumps draw or force air through the pipes.

Monitoring Equipment

Moisture content can be determined by accurately weighing a representative sample of material before and after drying moisture in an oven at 200 degree °F. A sample is dry when two successive weights are the same. Subtracting dry weight from initial weight gives moisture content, and dividing moisture content by initial weight gives percent moisture. Forage moisture meters, for determining moisture in the field, require a capability of measuring in the 20% - 70% moisture range.

Bag Breaking Equipment

Bag breaking equipment is available using two shafts with grabbing edges that rip and tear bags open with a tearing action, allowing the material contained within to fall from the mill to a trommel screen with large (7 inch) holes. The fines (small particles that pass through the holes) drop through onto a conveyor. A discharge conveyor for the bags that come off the trommel screen feeds directly into a dumpster for disposal. The machine can be fed one bag at a time or can be hopper and conveyor fed with a front-end loader. Throughput capacity is approximately 10 tons per hour.

Source: **Yard Waste Composting**, Guidebook for Michigan Communities, Michigan Department of Natural Resources, Resource Recovery Section.

Appendix E: Estimation Methods for Yard Waste Composting

It is difficult to accurately estimate the amount of yard waste a given community will have to compost, since variables such as population density, number of trees, average lawn size, and annual rainfall all influence the volumes generated. Further, since most existing yard waste composting programs do not weigh, measure, or test the materials that are composted, there is very little data available on yard waste characteristics or generation rates.

Since a community must estimate amounts in order to establish an adequate composting site, the following guidelines have been developed to assist in arriving at rough estimates. Logging actual quantities during a program's start-up years is the best way to arrive at a more accurate understanding of the amounts of yard waste generated by a community.

The first section of this appendix offers general estimated characteristics of yard waste. The second section shows the method that Dane County, Wisconsin has used to estimate land requirements for the county composting sites, assuming a one-year composting cycle for yard waste combined and a 50% volume reduction during the first month. The last section is a worksheet developed by Wisconsin DNR to aid communities in estimating composting land requirements, assuming an 18-month composting cycle and a 50% volume reduction in the first year.

I. Characteristics of yard waste

A. Density estimations

1. Leaves
   Loose 250 lbs/yd^3
   Vacuumed 350 lbs/yd^3
   Compacted 450 lbs/yd^3
2. Grass
   Assumes: 30 gallons bag used at 80% capacity = 24 gallons. 24 gallon weights approx. 50 lbs. [Note: This weight is used for estimation purposes only. For safety reasons, it is advisable that residents be requested to keep bags to a 30-lb maximum weight.]

   $$\frac{50\text{ lbs}}{24\text{ gal}} \times 7.48\text{ gal/ft}^3 \times 27\text{ ft3/yd}^3 = 421\text{ lbs/yd}^3$$

B. Moisture Content

1. Leaves: 30-40%
2. Grass: 60-70%

C. Reduction During Composting

1. Weight loss 30-50%
2. Volume reduction 50-80%

D. Generation rates (general guidelines)

1. Leaves

Assumes: suburban environment, single family units

10-40 (avg. 15-20) bags/dwelling unit/year
30 gal. bag = 10-15 lbs (compaction variable)
= 100-600 lbs/dwelling unit
avg. = 150-300 lbs/dwelling unit/yr

2. Grass

Assumes: 26-week growing season, 1 cut/2 weeks = 13 cuts/yr

For safety reasons, most communities requests a 30 lb maximum weight for trash bags.

1 bag/cut = 13 bags/dwelling unit/yr
30 gallon bag = 30 lbs
13 bags x 30 lbs = 390 lbs/dwelling unit/yr

II. Dane County Method for Estimation

Dane County's method for estimation of land requirements for composting for yard waste uses the windrow method, assuming a one-year composting time frame and a 50% volume reduction during the first month. This section was developed by Al Czecholinski, Dane County Dept. of Public Works, Dane County, Wisconsin.

A. General Guidelines

1. One acre per 3,000-4,000 cubic yards of yard waste.
2. Volume reduction of 50% in first month.
3. Generation rates vary greatly. Retain flexibility in site sizing and layout.

B. Leaf Composting Only

Because most of the leaves come in a relatively short time period (4-6 weeks), volume reduction will not be a factor in determining site size. By spring, the leaves will have reduced in volume by at least 50%. At that time, new windrows can be formed to make room for leaves that may be brought in after springtime yard clean-up activities.

C. Combined Grass and Leaf Composting

Material will be brought to the site over a 8-9 month period each year. With combined yard wastes, the volume reduction that takes place during the composting season should be considered in determining site size. Because it is assumed that combined yard wastes will reduce by approximately 50% during the first month of composting, a monthly flow sheet should be constructed to accurately determine site size. For example, the following sample flow sheet assumes a site is open from April - November and receives 1,000 cuyds of grass and other yard wastes for each of these months plus 6,000 cuyds of leaves from mid October through the end of November.

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Total
Delivered to site (mostly grass)	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	8,000
Remaining from previous months	0	500	1,000	1,500	2,000	2,500	3,000	3,500	3,500
Leaf collection	0	0	0	0	0	0	--6,000--		6,000
				Total delivered to site per year					14,000
				Maximum vol. on site at any time					9,500

Based on this flow sheet and the previously mentioned assumptions, the site would need to be about three acres. Basing the site size on the volume of yard waste as delivered would have indicated that approximately four acres would be necessary. Therefore, volume reduction is an important consideration in determining site size. It should be kept in mind that a compost site that is located immediately adjacent to urban development will likely need some additional land to serve as a buffer zone.

Note: Most types of yard waste will continue to reduce in volume after the first month and may eventually reduce in volume by as much as 80%. This analysis assumes that mixed yard waste from a given year, consisting of both leaves and grass clippings, is sufficiently composted by spring or early summer of the following year to be removed from the site as space for incoming material is needed.

III. Worksheet for Calculating Compost Site Size

Worksheet for calculating the size of a compost site for yard wastes, assuming an 18-month compost time and a 50% volume reduction in the first year.

1. How many single family dwelling units? ______________
A

2. Assume each household generates:

200 lbs leaves (about 0.8 yd^3 loosely packed)
400 lbs grass (about 1.0 yd^3)

Then the volume of waste generated is:

______________ x 0.8 yd^3 = ______________ yd^3 total vol. leaves
A B

______________ x 1.0 yd^3 = ______________ yd^3 total vol. grass
A C

3. What percentage of the total volume will be collected? Survey municipal collection crews or private haulers to determine the percentage of households setting out bags of yard wastes. Consider the impact of a "home composting" information campaign.

leaves ______________ %
D

grass ______________ %
E

4. ______________ x ______________ = ______________ yd^3 leaves to be composted annually
B D

______________ x ______________ = ______________ yd^3 grass to be composted annually
C E

______________ total
F

5. How much volume is left after one year?

How long will compost material be on site? ______________ months

For a low-technology composting program (turning windrows once per month; little or no addition of water), assume an 18-month retention time. Also, assume that the first year's volume of yard waste is reduced by 50% after one year on site.

______________ yd^3 x 0.5 = ______________ yd^3 yard wastes remaining after one year.
F G

6. To calculate the potential maximum volume on site at any time, add the second year's incoming volume.

______________ yd^3 + ______________ yd^3 = ______________ yd^3 on site
F G H second year

7. Assume one acre of land is needed to compost 3,000 yd^3 (cubic yards) of yard wastes.

______________ yd^3 $\div$ 3,000 yd^3/acre = ______________ acres needed
H

This is the range of acreage needed to compost 3,000 yd^3. A buffer area to surround the working site will need to be added to this acreage.

Source: **Municipal Yard Waste Composting**, A Handbook for Wisconsin Communities, Dane County Department of Public Works, July 1988.

Appendix F: Collection Options

Collection Options

Procedure and/or Equipment	Advantages	Disadvantages
A. Bagged Leaves	Keeps leaves out of street and prevents blowing leaves. Pickup not sensitive to weather. Pickup at low cost without specialized equipment. Instructions can be printed on bags provided by the town.	Cost of bags. Time required for debagging. Plastic in finished compost must be avoided.
1. Bag type:		
(a) Nondegradable plastic.	Lower cost of bag. Debris can be removed when bag is emptied.	Costs and possible shortage of labor for emptying bags.
(b) Degradable plastic.	Information is still being collected on the use of these bags for yard waste collection and decomposition during composting.	
(c) Degradable paper.	Convenience in bagging and greater compaction than with plastic bags.	Higher cost of bag Extra effort in the distribution of special bags. Shredding may be required. Possible increase in time needed for composting.
2. Equipment and procedure.		
(a) Compactor truck.	Large quantity per load due to compaction.	High equipment cost unless the compactor is used for other purposes

(i) Empty bag into compactor.	Maximum opportunity for removal of debris. Efficient dumping into windrows. Eliminates debagging operation at site.	Inefficient use of compactor.
(ii) Empty bag at composting site.	Pickup may be quicker.	Inconvenience in emptying bags and forming piles or windrows.
(b) Dump truck	No specialized equipment.	Small quantity per load in absence of compaction.

B. Loose Leaves

1. Location of piles:

(a) Curbside.	Avoid problems associated with leaves in the street.	Raking of leaves by collection crew is labor intensive especially when collection is by front end loader. More extraneous material in leaves.
(b) In street.	Most convenient for collection in absence of parked cars.	Danger to children playing in leaves. Danger of fire from catalytic converters. Either raking or repeated collection if cars are parked on the street. More extraneous material in leaves.
2. Vacuum leaf collector with discharge into wire or mesh-covered box on dump truck	Leaves are shredded to some degree and are compacted, especially if somewhat damp.	Ineffective if excessively wet or frozen. Dust if dry. Noise.

or trailer.		Moderate expense for specialized equipment.
(a) Mounting options: (i) On trailer with discharge into truck.	Load one truck while another is in transit.	Potential danger to operator and inconvenience from operation at rear of truck.
(ii) On front of truck (on hoist used for snow plow)	Driver can see operator.	Not generally available with belt drive.
(iii) On trailer with yard waste box.	Can be pulled with any type of truck including one equipped for snow plowing and sanding.	Inconvenience in backing trailer to unload. Potential danger to operator and inconvenience from operation at the rear of the truck.
(b) Drive options: (i) Belt.	Belt drive reduces vibration from impeller to engine which reduces maintenance costs and increases service life.	Higher initial cost
(ii) On engine crankshaft.	Lower initial costs.	Vibration from impeller increases maintenance costs and decreases service life.
(iii) Power take-off.	Intermediate cost relative to other options.	Intermediate cost relative to other options.
3. Catch basin cleaner.	Large units (12 inch suction hose) are fast and effective with sufficient suction for collection	Small units (6-8" suction hose) are slow and clog in excessively wet or freezing

	of wet leaves.	conditions. Very high initial costs Rather high maintenance costs. Noise.
4. Front end loader and dump truck.	Specialized equipment is optional. Effective with wet and/or slightly frozen leaves. Efficiency can be increased if front end loader works with a small snow plow and final cleanup is with a street sweeper.	Leaves must be raked into the street. (A tractor-pulled rake can be used only in suburban areas). Inefficient with dry leaves.
5. Front end loader and compactor truck with chute for receiving leaves.	Same as in number 4 except that effective capacity is much greater with a compactor.	Same as in number 4.

Source: **Leaf Composting: A Guide for Municipalities**, University of Connecticut Extension Service, January 1989.

Appendix G: Public Information and Involvement Bibliography

Public Information and Involvement Bibliography

Operating a Recycling Program: A Citizen's Guide, U.S. Environmental Protection Agency, SW-770, 1979.

Recycling in Your Community: A Guide to Make It Happen, Fresno County Economic Opportunities Commission, Fresno, CA, 1979.

Recycling Pays Off, A Publicity Guide for Recycling Operations, California Waste Management Board, Sacramento, CA, 1983.

Source Separation: The Community Awareness Program in Somerville and Marblehead, Mass, U.S. Environmental Protection Agency, SW-551, 1976.

So You Want to Get News in the Newspaper, St. Paul Dispatch/Pioneer Press, St. Paul, MN, 1981.

Twin Cities Publicity Handbook, Lukaszewski, J., Media Information Systems Corp, New Brighton, MN, 1983.

Appendix H: Kansas Don't Spoil It! Program (Yard Waste Brochure)

Take a Break from the Rake

Unless you enjoy raking the entire lawn, follow this plan: Mow from the outer edge of your yard, moving in ever-decreasing circles toward the center. With a side discharge mower, make sure it's blowing the clippings closer to the central point. The repeated chops will reduce the clippings into useful mulch.

How Does Mulching Work?

Mulch – any organic material spread over the soil – conserves water, reduces weeds and keeps soil temperatures from becoming too hot or too cold. It stops erosion, adds nutrients to the soil and helps you create a healthy soil environment for your garden and landscaping plants.

Grass clippings make excellent mulch, in part, because they consist mostly of water. They decompose quickly. In as little as 14 days, grass clippings can release vital nutrients back into your lawn.

Why Throw Away Money?

Every time you throw out a garbage bag of grass clippings, you're throwing out up to 1/4 pound of usable organic nitrogen that could help fertilize your yard. Reduce your fertilizer costs. Recycle those clippings back into the lawn. Your efforts will also help cut waste management costs in Kansas. During the summer, grass clippings can account for 30% of residential trash. That not only eats up our valuable landfill space; it contributes to methane gas and leachat problems.

Why Buy?

Don't look for mulch at the store. place to find mulch is in your ow grass clippings, leaves and woo make excellent mulch.

Consider

Grass cli
waste
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loa
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nfested
rs, weeds
hes.

Yard Waste

The secret's out of the bag.

KANSAS

DON'T SPOIL IT!

Printed on recycled and recyclable paper ♻

KANSAS
DEPARTMENT OF HEALTH & ENVIRONMENT
BILL GRAVES, GOVERNOR
Gary R. Mitchell, Secretary

Kansas Don't Spoil It! Program features and major events 6/94-12/97:

- In response to public interest and the recognition of the limited public awareness of solid waste issues, the Bureau of Waste Management, as part of the development of state solid waste management plan, investigated public education possibilities and options.
- A public awareness and education concept was developed in 1994 and introduced at the first *Composting Works!* Conference in Lindsborg, March 1995. KDHE took surveys and feedback from everyone to meet needs of individual counties and municipalities and the private sector. Based upon the positive feedback, the campaign was initiated and customization of posters and brochures became an integral part of the program concept.
- Through a competitive bid process Corporate Communications Group, Inc. (CCG) of Overland Park, Kansas was hired as the contractor for the Kansas Don't Spoil It! Campaign.
- Governor Graves launched Kansas Don't Spoil It! Campaign at the 1996 Kansas State Fair.
- A Kansas Don't Spoil It! traveling display unit was developed and is used at numerous conferences, trade shows, state and county fairs.
- CCG, Inc. rotates four Billboards ("Actions Speak", "recycle cycle", "Keep Kansas clean" and "combined effort" posters) at 15 locations in the communities of Kansas City, Kansas, Johnson County, Topeka, Pittsburg, Manhattan, Salina, Dodge City, Hays and Wichita from December 1996 through May 1998.
- CCG, Inc. developed, produced and is marketing ten posters, seven posters, five five-second radio public service announcements (PSA's), six newsprint PSA's, one ten minute video and one ten second Television PSA, various solid waste related press releases and a solid waste catalog of Kansas Don't Spoil It! materials (posters, brochures, bumper stickers, magnets, caps, mugs, shirts and related marketing items) for use by local solid waste officials, recycling and composting facilities, cities, counties and interested parties.
- Kansas Don't Spoil It! bumper stickers began appearing on Kansas motor pool vehicles and at various Kansas Wildlife and Parks facilities in 1997. Additional agency and private sector involvement is being explored in 1998.
- Every public and private elementary and secondary school in the state received a Kansas Don't Spoil It! packet of posters and materials in 1996.
- A **Kansas Don't Spoil It! Day** was created at the **Kansas State Fair** on Friday, September 12, 1997. It featured several composting and vermiculure demonstrations at the Kansas Farm Bureau Arena.
- A Kansas Don't Spoil It! *Activities Guide* for elementary schools was developed for public education and a **Kansas Don't Spoil It! WEEK** during Earth Day Week (April 19-25, 1998).
- Expansion of the Kansas Don't Spoil It! Campaign into more educational avenues including Environmental Youth Fairs, more curricula support and more radio, television and newsprint activity are being planned for 1998 and 1999.

KANSAS
DON'T SPOIL IT!

Division of Environment
Bureau of Waste Management
Phone (785) 296-1600

Printed on Recycled Paper

Forbes Field, Building 740
Topeka, KS 66620-0001
FAX (785) 296-8909

KANSAS DON'T SPOIL IT!

Kansans reminded to be aware of solid waste management practices.

When you have a good thing — like Kansas — it's worth taking care of. A new statewide public awareness campaign is helping remind Kansans of the importance of doing just that.

The Kansas Department of Health and Environment knows a successful solid waste management program depends on a well-educated public. For that reason, the KDHE has adopted "Kansas: Don't Spoil It!" as the guiding theme for a program designed to bring attention to solid waste management issues across the state. The "Don't Spoil It!" program will address a variety of solid waste issues and problems, including recycling, composting, household hazardous waste, illegal dumping, waste reduction, etc. The goal is to positively influence waste management practices across the state and to encourage persons to re-think traditional methods of managing waste.

Here's more information about the "Kansas: Don't Spoil It!" program:

- The public awareness and education initiative is one component of an overall restructuring of solid waste management methods across Kansas and the nation. New state and federal laws and regulations require counties to develop local solid waste plans. The Kansas Legislature agreed that public awareness be a key component of that effort and passed legislation to include public education in the process.

- A two-year budget of approximately $500,000 will be devoted to the public awareness component of the solid waste management plan. Funding is from the state's $1 per ton landfill tipping fee.

- "Kansas: Don't Spoil It!" was selected as the theme after review and feedback from solid waste management officials across the state.
  "Don't Spoil It!" is a message that. . .
  - √ Automatically places the reputation of Kansas on high ground.
  - √ Is non-accusatory, as Kansans are known for possessing a remarkable amount of pride in their state and its resources.
  - √ Includes a call for action. It is a matter of our behavior that keeps Kansas clean and beautiful. It is up to us not to tarnish the good environment of Kansas. It us up to us not to spoil Kansas.

- A variety of methods will be used to spread the "Kansas: Don't Spoil It!" message, including, but not limited to, billboards, brochures, posters, bumper stickers and public service announcements.

- The "Kansas: Don't Spoil It!" theme will be incorporated into every educational item, as appropriate. By providing information through a variety of methods, individuals, local government officials and private businesses can make informed decisions.

- The inherent diversity of Kansas requires an awareness program that is flexible and adaptable to the various parts of the state, be it east or west, urban or rural. Local input will be an integral component of the "Kansas: Don't Spoil It!" effort.

- The KDHE will provide information and encouragement to local officials to stimulate initiation of environmentally sound waste management projects. However, local officials will have input in determining what issues are relevant to their local public awareness efforts.

- Certain items will be customized to meet local informational needs. These items will primarily include posters and technical brochures. Information which can be added includes facility locations, hours of operation, phone numbers, materials received, etc.

- The program will attempt to develop private sector partnerships by developing a business and industry relations campaign. Businesses will be encouraged to assist in the distribution of the "Kansas: Don't Spoil It!" message and further the implementation of the public awareness program.

- The "Kansas: Don't Spoil It!" program is being administered by the Kansas Bureau of Waste Management of the KDHE. Through a public bidding process, Corporate Communications Group, Inc., a Kansas-based marketing firm, was selected to develop and implement the program.

For further information, contact:

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corpcom@primenet.com

or

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uskant2n@ibmmail.com

Appendix I: Kansas Statutes and Regulations

K.S.A. 65-3402(c) and (y), and Draft Composting Regulations

K.S.A. 65-3402

(c) **"Solid waste processing facility"** means incinerator, composting facility, household hazardous waste facility, waste-to-energy facility, transfer station, reclamation facility or any other location where solid wastes are consolidated, temporarily stored, salvaged or otherwise processed prior to being transported to a final disposal site. This term does not include a scrap material recycling and processing facility.

(y) **"Composting facility"** means any facility that composts wastes and has a composting area larger than one-half acre.

February 5, 1997

Kansas Department of Health and Environment
Proposed New Regulation

28-29-25a. Small composting sites. This regulation shall apply to each composting site that has a composting area of one-half acre or less, but shall not apply to backyard composting.

(a) Site design. The owner or operator of each composting site shall design and construct the composting site to meet all of the following requirements:

(1) Composting surface and drainage. Storm water run-on shall be prevented from entering the receiving, processing, curing, or storage areas by use of berms or other physical barriers.

(2) Site access.

(A) Signs shall be posted to provide the following information:

(i) site hours;

(ii) traffic flow;

(iii) materials appropriate for composting; and

(iv) emergency contact.

(B) Unauthorized dumping shall be discouraged by access control.

(3) Storage. Finished compost shall be stored for no more than 18 months.

(b) Site operations.

(1) The owner or operator of each composting site shall meet both of the following operating requirements:

(A) minimize odors; and

(B) control vectors, dust, litter, and noise.

(c) Site closure. Within six months of last receipt of compostable material, the site owner or operator shall remove all materials from the site.

(d) Registration. Each owner or operator of a small composting site shall submit a registration application to the department on a form supplied by the department. (Authorized by and implementing K.S.A. 1996 Supp. 65-3406, as amended by L. 1997, Ch. 139, sec. 1; effective P-______________________.)

February 5, 1997

Kansas Department of Health and Environment
Proposed New Regulation

28-29-25b. Yard waste composting facilities with a composting area larger than one-half acre. (a) Facility design. The owner or operator of each facility that composts yard waste shall design and construct the composting facility to meet all of the requirements of 28-29-25a(a) plus the following requirements:

(1) Composting surface and drainage.

(A) The surface of the composting area shall be capable of supporting the equipment which will be used.

(B) The composting area shall be graded to prevent ponding of liquids.

(C) Run-off from the receiving, processing, curing, or storage areas shall be prevented from entering waterways by use of settling ponds, grass buffer areas, or other physical barriers.

(2) Facility access. Access roads shall be passable in wet weather. Yard waste composting facilities shall be exempt from the all-weather access road requirement of K.A.R. 28-29-23(e).

(3) Capacity and storage.

(A) The facility shall have the capacity to store the following materials:

(i) incoming materials waiting to be processed;

(ii) materials being processed; and

(ii) finished compost, not to exceed 18 months production.

(b) Facility operations. The owner or operator of each facility that composts yard waste shall meet all of the requirements of 28-29-25a(b) plus the following requirements:

(1) post a sign designating disposal sites for waste which is not acceptable for composting at the facility;

(2) segregate incoming waste from finished compost; and

(3) remove all finished compost within 18 months of the completion of the composting process.

(c) Facility closure. The owner or operator of each facility that composts yard waste shall meet all of the requirements of 28-29-25a(c).

(d) Permit applications. The owner or operator of each facility that composts yard waste shall submit a permit application to the department on a form supplied by the department. The applicant shall include the following items in the permit application:

(1) Facility design plan. The facility design plan shall contain the following items:

(A) a topographic map (U.S. Geological Survey 7.5 minute series) of the area indicating the following information:

(i) the facility boundary; and

(ii) the property boundary;

(B) a soil map (U.S. Department of Agriculture Natural Resources Conservation Services) of the area;

(C) a 100-year floodplain map (Federal Emergency Management Agency) of the area;

(D) a detailed drawing of the facility that indicates the location of the following features:

(i) roads;

(ii) buildings and equipment to be installed;

(iii) access control;

(iv) utilities;

(v) storm water system; and

(vi) site grading.

(2) Operations plan. The operations plan shall contain the following information:

(A) the anticipated annual quantity of waste to be received, and seasonal variations of quantity of waste to be received;

(B) job titles of persons responsible for operation, control, and maintenance of the facility;

(C) equipment to be used;

(D) methods to control traffic and to expedite unloading;

(E) methods for measuring incoming waste;

(F) methods to control the types of waste received;

(G) methods for removing non-compostable wastes from the incoming waste stream, including procedures for removal, storage, and disposal of any hazardous wastes;

(H) location of disposal sites for non-compostable wastes;

(I) methods to minimize, manage, and monitor odors;

(J) disease vector, dust, litter, and noise control measures;

(K) leachate and storm water control measures;

(L) a fire protection and control plan; and

(M) plans for use of compost.

(3) Closure plan. The closure plan shall include the following information:

(A) steps necessary to close the facility;

(B) final surface contours; and

(C) a closure cost estimate based on the cost of removing and disposing of the maximum amount of wastes which can be contained in approved waste storage.

(Authorized by and implementing K.S.A. 1996 Supp. 65-3406, as amended by L. 1997, Ch. 139, sec. 1; effective P-______________________________.)

February 5, 1998

Kansas Department of Health and Environment
Proposed New Regulation

28-29-25c. Manure composting facilities.

(a) The owner or operator of each facility that composts manure shall design and construct the facility to meet all of the requirements of 28-29-25b(a) plus the following requirements:

(1) Composting surface and drainage. Leachate control shall be provided wherever leachate is generated.

(2) Facility access. Access roads shall be of all-weather construction and negotiable at all times by trucks and other vehicles. Load limits on bridges and access roads shall be sufficient to support all traffic loads which will be generated by use of the facility.

(b) Facility operations. The owner or operator of each facility that composts manure shall meet all of the requirements of 28-29-25b(b) plus begin processing incoming waste within three days of receipt.

(c) Facility closure. The owner or operator of each facility that compost manure shall meet all of the requirements of K.A.R. 28-29-25a(c).

(d) Permit applications. The owner or operator of each facility that composts manure shall submit a permit application to the department on a form supplied by the department. The applicant shall include the following items in the permit application:

(1) Facility design plan. The facility design plan shall contain all items required by K.A.R. 28-29-25b(d)(1).

(2) Operations plan. The operations plan shall contain all information required by K.A.R. 28-29-25b(d)(2) plus the following information:

(A) leachate and National Pollutant Discharge Elimination System storm water control measures; and

(B) plans for operations during wind, heavy rain, snow, freezing temperatures, or other inclement weather conditions.

(3) Closure plan. The closure plan shall include all the information required by K.A.R. 28-29-25b(d)(3). (Authorized by and implementing K.S.A. 1996 Supp. 65-3406, as amended by L. 1997, Ch. 139 sec. 1; effective P-__________.)

February 5, 1998

Kansas Department of Health and Environment
Proposed New Regulation

28-29-25d. Source-separated organic waste composting facilities.

(a) Facility design. The owner or operator of each facility that composts source-separated organic waste shall design and construct the facility to meet all of the requirements of 28-29-25c(a).

(b) Facility operations. The owner or operator of each facility that composts source-separated organic waste shall meet all of the requirements of 28-29-25c(b) plus the following requirements:

(1) limit access to the facility to hours when an attendant is at the facility;

(2) if the waste contains vegetative food wastes, use one of the following methods as a process to further reduce pathogens (PFRP):

(A) windrow composting method. When using this method, the following conditions shall be met:

(i) aerobic conditions shall be maintained within the windrow;

(ii) the waste shall attain a temperature of 55° C or greater for at least 15 days during the composting period; and

(iii) the windrow shall be turned a minimum of five times during the high temperature period.

(B) aerated static pile composting method. When using this method, the waste shall be covered with six to 12 inches of insulating material and maintained at a temperature of 55° C or greater for a minimum of three consecutive days.

(C) enclosed-vessel composting method. When using this method, the waste shall be maintained at a temperature of 55° C or greater for a minimum of three consecutive days.

(D) any other method approved by the department;

(3) record the following information:

(i) temperature and moisture content of materials during the composting process, in accordance with the operating plan;

(ii) daily volume or weight of waste received;

(iii) source of waste;

(iv) all lab analyses required in subsection (e) of this regulation;

(v) retention time of the finished compost; and

(vi) volume of recovered materials; and

(4) maintain records of all information required by this regulation for a minimum of three years.

(c) Facility closure. The owner or operator of each facility that composts source-separated organic waste shall meet all of the requirements of K.A.R. 28-29-25a(c) plus the following requirements:

(1) Within 10 days of ceasing operation, the owner or operator shall remove all material from the facility.

(2) The owner or operator shall arrange for a final cleaning of all containers, equipment,

machines, floors, and site surfaces having come in contact with source-separated organic waste or solid waste.

(d) Permit applications. Each owner or operator of a facility that composts source-separated organic waste shall submit a permit application to the department on a form supplied by the department. The applicant shall include the following items in the permit application:

(1) Facility design plan. The facility design plan shall contain all items required by K.A.R. 28-29-25b(d)(1) plus the following items:

(A) a flow diagram of the proposed processing steps involved in recovering and processing source-separated organic waste, including a total mass balance; and

(B) plan and profile views of the facility indicating the following features:

(i) roads;

(ii) water drainage;

(iii) existing and final grade;

(iv) facility superstructure;

(v) utilities; and

(vi) all other structures.

(2) Operations plan. The operations plan shall contain all information required by K.A.R. 28-29-25c(d)(2) plus the following information:

(A) sources of waste to be received;

(B) a description of equipment proposed to be used in composting, including equipment specifications and manufacturer's performance standards. The proposed equipment shall be compatible with the proposed process and throughput;

(C) a description of any additives used in the process;

(D) methods for maintaining biological conditions;

(E) a quality assurance/quality control plan which outlines the monitoring, sampling, and analysis plans for testing the compost process and product; and

(F) a contingency operations plan (in the event of equipment failure, power outages, natural disasters, fire, receipt of prohibited materials, or similar interruptions of normal activities), including designation of permitted disposal sites for incoming waste, leachate, and hazardous waste.

(3) Closure plan. The closure plan shall include all the information required by K.A.R. 28-29-25b(d)(3).

(e) Testing.

(1) The owner or operator of each facility that composts source-separated organic waste shall obtain samples of compost produced at the facility and have the samples analyzed for the following parameters:

(i) oxygen consumed;

(ii) electrical conductivity;

(iii) pH;

(iv) pathogens;

(v) fecal coliform; and

(vi) salmonella.

(2) If departmental certification is available for an analysis, only a laboratory that is certified for the analysis by the department shall perform the analysis.

(3) An appropriate monitoring schedule will be set by the department as part of the facility permit. (Authorized by and implementing K.S.A. 1996 Supp. 65-3406, as amended by L. 1997, Ch. 139, sec. 1; effective P-________________________.)

February 5, 1998

Kansas Department of Health and Environment
Proposed New Regulation

28-29-25e. Solid waste composting facilities. This regulation shall apply to all solid waste composting facilities except facilities that compost only yard waste , manure, source-separated organic waste, or any combination of yard waste, manure, and source-separated organic waste.

(a) Facility design. The owner or operator of each solid waste composting facility shall design and construct the facility to meet all of the requirements of 28-29-25c(a) plus the following requirements:

(1) The receiving, processing, production, and curing areas shall be covered by a roof.

(2) The floor structure shall have a permeability of 10^{-7} cm/sec or less.

(b) Facility operations. The owner or operator of each solid waste composting facility shall meet all of the requirements of 28-29-25d(b).

(c) Facility closure. The owner or operator of each solid waste composting facility shall meet all of the requirements of K.A.R. 28-29-25d(c).

(d) Permit applications. Each owner or operator of a solid waste composting facility shall submit a permit application to the department on a form supplied by the department. The applicant shall include the following items in the permit application:

(1) Facility design plan. The facility design plan shall meet all of the requirements of K.A.R. 28-29-25d(d)(1) plus the following:

(A) information on the permeability of the floor structure; and

(B) a flow diagram of the proposed processing steps involved in recovering recyclable materials and mixed organic material from solid waste, including a total mass balance.

(2) Operations plan. The operations plan shall contain all information required by K.A.R. 28-29-25d(d)(2).

(3) Closure plan. The closure plan shall include all the information required by K.A.R. 28-29-25b(d)(3).

(e) Testing. The owner or operator of each solid waste composting facility shall comply with the testing requirements of K.A.R. 28-29-25d(e) plus have samples of compost produced at the facility analyzed for the following parameters:

(1) arsenic;

(2) cadmium;

(3) chromium;

(4) copper;

(5) lead;

(6) mercury;

(7) molybdenum;

(8) nickel;

(9) selenium; and

(10) zinc. (Authorized by and implementing K.S.A. 1996 Supp. 65-3406, as amended by L. 1997, Ch.139, sec.1; effective P-________________________.)

February 5, 1998

Kansas Department of Health and Environment
Proposed New Regulation

28-29-25f. Standards for finished compost. (a) Compost is not a finished product if the parameter limits listed in table 1 of this regulation are exceeded. The parameter limits listed in table 1 are....

TO BE DEVELOPED

(b) All limits presented in table 1 apply to material leaving the compost site. If the material leaving the compost site exceeds the parameters listed in table 1 the material is solid waste. (Authorized by and implementing K.S.A. 1996 Supp. 65-3406, as amended by L. 1997, Ch. 139, sec.1; effective P-________________________.)

Appendix J: Glossary

Glossary

Aerated Pile Composting. See Static Pile Composting.

Aerobic Composting. Decomposition of organic materials by bacteria in the presence of oxygen.

Agricultural waste means solid waste resulting from the production of farm or agricultural products. (Draft regulations)

Anaerobic Digestion. Decomposition of organic materials in the absence of oxygen.

Backyard composting means composting of yard wastes that is done on a small scale. These yard wastes are usually collected from a single residence but may include vegetative materials collected from other sources. (Draft regulations)

Buffer Zone. Area of land between the composting facility and homes or other sensitive land uses, which shields these abutting uses from impact of the operation. The buffer zone could include vegetation.

Compaction. Compressing of solid waste to reduce its volume. Compaction allows for more efficient transport.

Compost. Compost means organic material resulting from biological decomposition of waste which can be used as a soil conditioner, soil amendment, or fertilizer.

Composting area means the area used for receiving, processing, curing, and storage of compostable materials and compost. (Draft regulations)

Composting Facility means any facility that composts wastes and has a composting area larger than one-half acre. (K.S.A. 65-3402(y))

Composting Pad. An area within the composting site with a surface upon which the organic materials are processed.

Contaminant. A substance capable of polluting a primary material by contact or mixture.

Cubic Yard. The standard measure of waste volume for leaves, which is roughly equivalent to 500 pounds or ¼ ton, assuming an average rate of compaction.

Curing. The final stage of composting, after much of the readily metabolized material has been decomposed, in which the compost material further stabilizes.

Front-End Loader. A tractor vehicle with power-driver loading equipment at the front of the vehicle. Sometimes referred to as a bucket loader.

Groundwater means that part of subsurface water in the ground that is in the zone of saturation. (Draft regulations)

Heavy Metals. Metallic elements with higher molecular weights. At certain concentrations, some elements present human health risks, may be poisonous to plants, or adversely affect livestock.

Inorganic. Matter in which there are no carbon-to-carbon bonds, such as minerals, which therefore will not undergo biological decomposition.

Leachate means liquid that has been or is in direct contact with solid waste. (Draft regulations)

Leaves. Deciduous and coniferous seasonal deposition, grass clippings, weeds, hedge clippings, and garden waste.

Municipal Solid Waste. (MSW); means garbage, refuse and other discarded materials including, but not limited to, solid, semisolid, sludges, liquid and contained gaseous waste materials resulting from industrial, commercial, agricultural and domestic activities. Solid waste does not include hazardous wastes as defined by subsection (f) of K.S.A. 65-3430, and amendments thereto, recyclables or the waste of domestic animals as described by subsection (a) (1) of K.S.A. 65-3409, and amendments thereto. (K.S.A. 65-3402(a))

Non-Compostable. Material that will not decompose naturally or whose decomposition products are toxic.

N:P:K Ratio. Refers to the ratio of nitrogen to phosphorus to potassium in a compost product, indicating its fertilizer value.

Organic Waste. Waste composed of materials which contain carbon-to-carbon bonds and are biodegradable. includes paper, wood, food wastes and yard wastes.

Pathogens. Organisms that are capable of producing infection or diseases, often found in waste materials. Pathogens are killed by the high temperatures of the composting process.

Percolation. Downward movement of water through the pores or spaces of rock or soil.

pH. A measure of how acidic (pH less than 7) or basic (pH above 7) a material is. A pH of 7 is considered neutral.

Putrescible wastes means solid waste which contains organic matter capable of being decomposed by microorganisms and which are capable of attracting or providing food for birds and disease vectors. (Draft regulations)

Resource Recovery. A term used to describe the extraction of economically useful materials and/or energy from solid waste. Often refers to the burning of waste for energy.

Runoff. Any liquid originating from any part of a facility that drains over the land.

Screening. The process of passing compost through a screen or sieve to remove large organic or inorganic materials and improve the consistency and quality of the end-product.

Shredder. A mechanical device used to break up waste materials into smaller pieces, usually in the form of irregularly shaped strips. Shredding devices include hammermills, shears, drum pulverizers, wet pulpers and rasp mills.

Soil Amendment/Soil Conditioner. A soil additive which stabilizes the soil, improves its resistance to erosion, increases it permeability to air and water, improves its texture and the resistance of its surface to crusting, makes it easier to cultivate or otherwise improves its quality.

Source-separated organic waste means organic material that has been separated from non-compostable material at the point of generation. It includes vegetative food waste, soiled or unrecyclable paper, or yard waste in combination with these materials. (Draft regulations)

Stabilization. The decomposition of compost to the point where it does not re-heat when wetted nor give off offensive odors.

Static Pile Composting. A method of composting in which oxygen and temperature levels are mechanically controlled by forced aeration using blowers.

Substrate. The organic material on which the decomposing microorganisms live and feed.

Vector. Any organism capable of transmitting a pathogen to another organism.

Vegetative food waste means food waste and food processing waste from materials such as fruits, vegetables, and grains. It does not include animal products or byproducts, such as dairy products, animal fat, bones, or meat. (Draft regulations)

Volume Reduction. The processing of waste materials to decrease the amount of space they occupy. Compaction, shredding, composting and burning are all methods of volume reduction.

Windrow. An elongated compost pile, usually about six to 12 feet high and up to hundreds of feet long.

Windrow Composting. The composting of organic materials in a series of elongated piles called windrows. The windrows are turned periodically to aerate and mix the waste materials to speed up decomposition and reduce odor.

Yard Waste means vegetative waste generated from ordinary yard maintenance, and includes grass clippings, leaves, branches less than .5 inches in diameter, and garden wastes. (Draft regulations)

Source: **Leaf and Yard Waste Composting Manual**, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, MA.

Updated 2/98 to include Kansas Statutes and Draft Regulations on composting.

Appendix K: Further Reading Guides and Manuals

Further Reading Guides and Manuals

Periodicals

BioCycle
Journal of Composting and Recycling
'The JG Press, Inc.
419 State Avenue
Emmaus, PA 18049
(215) 967-4135
Monthly magazine

Compost Matters
Woods Hole Institute
1850 Old Rome Road
Mt Vernon, Maine 043 52
Newsletter plus numerous speciality publications on soil amendments and composting.

Compost Science & Utilization
419 State Avenue
Emmaus, PA 18049
Quarterly journal connecting researchers in numerous fields.

COMPOSTING News
13727 Holland Road
Cleveland, OH 44142-3920
(216) 362-7979 fax: (216) 363-4623
Monthly report on agriculture, industrial, MSW and home composting.

MSW Management
The Journal for Municipal Solid Waste Professionals
Forester Communications
5638 Hollister Ave # 301
Santa Barbara, CA 93117
(805) 681-1300 fax: (805) 681-1312

Recycling Today
The Business Magazine for Recycling Professionals
GIE Inc., Publishers
4012 Bridge Ave
Cleveland, OH 44113-3320
Monthly magazine

Resource Recycling
Resource Recycling, Inc.
1206 NW 21st
Portland, OR 97209
(503) 227-1319 fax: (503) 227-6135
Monthly magazine

Resource Recovery Report
"a monthly review of resource recovery progress"
5313 38th St, NW
Washington, DC 20015
(202) 362-6034 fax: (202) 362-6632
Monthly magazine

Solid Waste Management
The University of Illinois at Chicago
Office of Solid Waste Management
School of Public Health
2121 West Taylor Street
Chicago, IL 60612-7260
Bimonthly newsletter

Waste Age
National Solid Waste Management Association
1730 Rhode Island Ave NW
Washington, DC 20036
(202) 861-0708 (800) 424-2869
Monthly magazine

The WASTE-LINE
Providing Waste Reduction Information to Industry
KY Partners State Solid Waste Reduction Center
Room 312, Ernst Hall
University of Louisville
Louisville, KY 40292

World Wastes
The Independent Voice
Argus Business of Argus Inc.
6151 Powers Ferry Rd
Atlanta, GA 30339-2941
(404) 955-2500
Monthly magazine

K-State Contacts

William M. Eberle, Extension Specialist
Cooperative Extension Service
Department of Agronomy
Kansas State University
Throckmorton Hall
Manhattan, KS 66506-5504
(913) 532-5776 fax: (913) 532-6315

Carol Shanklin, Ph.D.
Food Service and Hospitality Industries
Environmental Issues Program
104 Justin Hall
Kansas State University
Manhattan, KS 66502
(913) 532-5521 fax: (913) 532-5504
(Provide food service operations and food processing waste analysis and research, technical advice on composting and processing, and material handling research.)

Recycling Organizations

Ron Albrecht Associates, Inc.
111 Chinquapin Round Road
PO Box 6352
Annapolis, MD 21401-0352
(301) 269-0147 fax: (301) 269-0175

E & A Environmental Consultants, Inc.
1130 Kildaire Farm Road, Suite 200
Cary, North Carolina 27511
(919) 460-6266 fax: (919) 460-6798

The Compost Council
114 Pitt St.
Alexandria, VA 22314
(703) 739-2401 fax: (703) 739-2407

Kansas Business and Industry Recycling Program
(Kansas BIRP)
2933 SW Woodside Drive, Suite C
Topeka, KS 66614-4181
(913) 273-6808 fax: (913) 273-2405

Kansas Recyclers Association
PO 70
Hutchinson, KS 67504
(316) 662-0551

National Recycling Coalition
1727 King Street, 1st Floor
Alexandria, VA 22314
(703) 683-9025 fax (703) 683-9026

Books

Backyard Composting, "Your Complete Guide to Recycling Yard Clippings", 1992, John W. Roulac, Harmonious Press, Ojai, CA.

Complete TRASH, “The best way to get rid of practically everything around the house', 1988, Norm Crampton, M. Evans and Company, NY.

Composting Source Separated Organics, 1994, Ed. staff of *BioCycle,* The IG Press, Inc., Emmaus, PA.

50 Simple Things Kids Can Do To Save The Earth 1990, The Earth●Works Group, Andrews and McMeel, A Universal Press Syndicate Company, Kansas City and New York.

Recycle Grass Clippings.
Professional Lawn Care Association of America
1000 Johnson Ferry Road
Suite C-135
Marietta, GA 30068-2112

The Recycler’s Handbook, “Simple Things You Can Do”, 1990, The Earth●Works Group, Earth Works Press, Berkeley, CA.

The Rodale Guide to Composting. Jerry Minnich, Majorie Hunt, and the editors of *Organic Gardening®,* 1979, Rodale Press, Inc., Emmaus, PA.

Site Managers Handbook, Wildcat Composting Equipment, 1993, Pine Hill Press, Inc., Freeman, SD.

Winning The Organics Game, The Compost Marketer’s Handbook, Rodney W. Tyler, ASHS Press, 1996, Alexandra, VA.

Kansas Department of Health and Environment
Bureau of Waste Management
Forbes Field, Building 740
Topeka, KS 66620-0001
Phone: (913) 296-1600

Appendix L: Sources

1. *Leaf and Yard Waste Composting Manual*, prepared for National Corn Growers Association, St. Louis, Missouri. Prepared by Michael H. Simpson and Peter Engel, E & A Environmental Consultants, Inc., Stoughton, Massachusetts.

   Sections: 1.0 - 1.9; 1.11
   2.1.6
   3.0 - 3.2.1
   3.4 - 3.6
   5.0 - 5.1.9
   6.0 - 6.7
   7.0 - 7.4.1; 7.7
   9.0 - 9.5
   10.1 - 10.13
   11.0 - 11.5
   12.1 - 12.6

2. *Management Strategies For Landscape Waste*, Illinois EPA, September 1989.

   Section: 2.0 - 2.1.5; 2.1.7
   8.5

3. *Municipal Yard Waste Composting A Handbook for Wisconsin Communities*, Dane County Department of Public Works, July 1988.

   Sections: 4.1 - 4.3
   7.8.3 - 7.8.4

4. *Composting Municipal Solid Waste*, Waste Age, August 1989, pp. 103-110.

   Section: 7.5 - 7.6

5. *Leaf Composting, A Guide for Municipalities*, The State of Connecticut Department of Environmental Protection, Local Assistance and Program Coordination Unit, Recycling Program, Prepared by the University of Connecticut Cooperative Extension Service, January 1989.

   Section: 7.8.1 - 7.8.2

6. *Compost Operations Manual*, Minnesota Pollution Control Agency, Groundwater and Solid Waste Division, St. Paul, Minnesota, May 1989.

   Section: 3.2.1 - 3.3
   8.0 - 8.4; 8.5.1

7. *Yard Waste Composting Guide*, Michigan Department of Natural Resources, Resource Recovery Section, Waste Management Division, Written by Jim McNelly of RECOMP, Inc., prepared and complied by Flowerfield Enterprises.

Sections: 10.1 - 10.13

8. *Decision-Makers Guide To Solid Waste Management*, EPA/530-5W-89-072

9. *Solid Waste and Emergency Response*, U.S. Environmental Protection Agency, November 1989.

Sections: 12.7 - 12.7.3

10. *Local Government Composting Guide*, Iowa Department of Natural Resources, 1991.

7. *Yard Waste Composting Guide*, Michigan Department of Natural Resources, Resource Recovery Section, Waste Management Division, Written by Jim McNelly of RECOMP, Inc., prepared and complied by Flowerfield Enterprises.

    Sections: 10.1 - 10.13

8. *Decision-Makers Guide To Solid Waste Management*, EPA/530-5W-89-072

9. *Solid Waste and Emergency Response*, U.S. Environmental Protection Agency, November 1989.

    Sections: 12.7 - 12.7.3

10. *Local Government Composting Guide*, Iowa Department of Natural Resources, 1991.

11. Selected articles from BioCycle Magazine.

Appendix M: Yard Waste Composting Facilities Permit List

YARD WASTE COMPOST SITES IN KANSAS
FEBRUARY 1998

Site Address	Permit Number
Cloud County Richard Mills Landfill Supervisor RR 1 Concordia, KS 66901 (785) 243-3504	107
Commanche County Jerry Heft Landfill Supervisor PO Box 776 Coldwater, KS 67029 (316)582-2933	108
Edwards County Ron Sitts Rt1, Box 18D Kinsley, KS 67547 (316) 659-2188	112
Ellis County Mike Graff County Engineer PO Box 691 Hays, KS 67601 (785) 628-9460	113
Ellsworth County Janet Andrews County Clerk 210 North Kansas Ellsworth, KS 67439 (785) 472-4003	114
Gray County Mark Trekell Quad County Engineer PO Box 688 Cimarron, KS 67835 (316) 855-7701	117
Lincoln County Stan Walker Landfill Supervisor 216 E. Lincoln Lincoln, KS 67455 (785) 524-4443	124
Meade County Mark Trekell Quad County Engineer PO Box 617 Meade, KS 67864 (316) 873-8720	128
Pawnee County Donna Pelton 715 Broadway Larned, KS 67550	133
Rice County John Achatz Highway Department 460 N. Logan Lyons, KS 67554 (316) 257-2231	137
City of Emporia Craig Jensen Solid Waste Supervisor PO Box 928 Emporia, KS 66801 (316) 342-1339	145
Anderson County Phylis Nolan, County Clerk 100 E. 4th Garnett, KS 66032 (785) 448-3724	147

City of Colby 152
Mike Albers
Public Works Director
585 N. Franklin
Colby, KS 67701
(785) 462-4410

Franklin County 159
Jim Cain
Director of Solid Waste
1418 S. Main, Suite 4
Ottawa, KS 66067
(785) 242-1110

Riley County 185
Dan Harden
Public Works Director
110 Courthouse Plaza
Manhattan, KS 66502
(785) 537-6330

Pawnee County 214
Donna Pelton
715 Broadway
Larned, KS 67550

Pottawatomie County 223
Leon Hobson
Rt. 1 Box 13 A
Westmoreland, KS 66549
(785)457-3631

City of Miltonvale 244
Darla Brummet
City Clerk
PO Box 248
Miltonvale, KS 67466
(785) 427-3380

City of Olathe 247
Doug Cochran
Environmental Engineer
PO Box 768
Olathe, KS 66051
(913) 829-0021

Kiowa County 281
Doyle Conrad
Landfill Supervisor
1002 S. Grove
Greensburg, KS 67054
(316) 723-2531

Linn County 421
Richard Long
County Engineer
Courthouse
Mound City, KS 66056
(913) 795-2229

Harper County Landfill 428
Mike Aldritt
Road Supervisor
Courthouse
Anthony, KS 67003
(316) 842-5240

Rawlins County Landfill 447
Tim Steele
705 Blaine St.
Atwood, KS 67730
(785) 626-3071

City of Topeka 452
Terry Bertels
Park Field Office
201 NW Topeka Blvd.
Topeka, KS 66603
(785) 295-3998

City of Garden City 508
Sam Curran
Street & Solid Waste Supervisor
301 N. 8th
Garden City, KS 67846
(316) 276-8263

Rawlins County 546
Terry Steele
705 Blaine
Atwood, KS 67730
(785) 626-3669

City of Chanute 628
John Venneman
Public Works Supervisor
PO Box 907
Chanute, KS 66720
(316)431-5200

City of Hillsboro 632
Jan Meisinger
City Clerk
118 E. Grand
Hillsboro, KS 67063
(316) 947-3162

City of Inman 638
Bill Maurer
City Superintendent
104 Main
Inman, KS 67546

City of Pratt 647
John scarborough
Sanitation Supervisor
126 S. Main
Pratt, KS 67124
(316) 672-2515

City of Iola 649
Gary Smith
Street & Alley Superintendent
Box 308
Iola, KS 66749
(316) 365-4900

City of Parsons 654
Mary Reed
City Manager
PO Box 1037
Parsons, KS 67357
(316) 421-7000

City of Gossel 657
Arlen Goetzen
PO Box 347
Gossel, KS 67053

Woodson County 662
Leslie Wilhite
Rt. 2, Box 231
Yates Center, KS 66783
(316) 625-8631

Derby Recycling 666
H.D. Mills
2756 S. West Street
Wichita, KS 67217
(316) 942-2031

Blixt Landfill 669
Larry Blixt, Owner
2646 Sage Rd.
Chapman, KS 67431
(785) 922-6608

Grant County Transfer Station 668
Frank Goldsby
Public Works Administrator
Box 506
Ulysses, KS 67880
(316) 353-1069

City of Bazine 672
Mayor
Main Street
Bazine, KS 67516
(785) 398-2495

Fort Riley 680
Environmental Branch
Attn: DEH(AFZN-DE-VE)
Fort Riley, KS 66442-6016
(785) 239-8652

City of Lorraine 681
Larry Klug
Maintenance Supervisor
Box 63
Lorraine, KS 67459
(785) 472-5322

City of Lindsborg 688
Wes Adell
Solid Waste Manager
101 S. Main
Lindsborg, KS 67456
(785) 227-3355

City of Abilene 692
Cliff Gibbs
Public Works Director
419 N. Broadway
Abilene, KS 67410
(785) 263-3510

City of Lyons 693
Dewey D. Breese
City Administrator
PO Box 808, 217 East Ave. South
Lyons, KS 67554
(785) 257-2320

City of Belleville 694
Don Danielson
Director of Public Works
PO Box 280, 1819 L Street
Belleville, KS 66935
(785) 527-2288

City of Cuba 695
Debbie Richecky
City Clerk
PO Box 47
Cuba, KS 66940-0047
(785) 729-3861

City of Clay Center 700
Jerry Davies
PO Box 117
Clay Center, KS 67432

City of Greenleaf 702
Monica Kruse
PO Box 113, 505 Fifth St.
Greenleaf, KS 66943
(785) 747-2858

City of Oswego 703
Cheri Peine, City Clerk
703-5th, PO Box 210
Oswego, KS 67356

City of Almena 705
Steve Callaway
415 Main, PO Box 277
Almena, KS 67622
(785) 669-2425

City of St. Marys 708
Steve Archer
City Manager
412 Bertrand
St. Marys, KS 66536
(785) 437-2311

City of Minneapolis 716
Lowell L. Parrish
City Clerk/Administrator
218 N. Rock St.
Minneapolis, KS 67467
(785) 392-2176

Dean Frankenbery 717
Wood Recycle and Compost Center
Div: Frankenbery Builders, Inc.
PO Box 4706
Wichita, KS 67204-0706
(316) 838-7211

City of Linn 719
Donald Leham
PO Box 66
Linn, KS 66953
(785) 348-5378

City of Little River 720
Randall M. Burdick
Mayor
320 Main
Little River, KS 67457
(785) 597-6260

City of Glen Elder 721
Geneva Winkel
PO Box 55
Glen Elder, KS 67446
(785) 545-3322

City of Bushton 726
Jerry Huff
Superintendent of Utilities
217 S. Main
Bushton, KS 67424-0194
(316) 562-3407

City of El Dorado 727
Donald B. Larson
Director of Public Works
222 E. Second
El Dorado, KS 67402
(316) 321-9100

Decatur County 728
Ralph D. Unger
Chairman Board of County Commissioners
PO Box 28
Oberlin, KS 67749
(785) 475-8101 or 8102

City of Stafford 729
Laverne "Curly" Girard
Public Works Dept.
112 W. Broadway
Stafford, KS 67578
(316) 234-5011

City of Salina 731
Robert Ash
Parks & Forestry Superintendent
300 W. Ash
Salina, KS 67401
(785) 826-7275

City of Ogden 732
Wayne Henson
Mayor
222 Riley Avenue
Ogden, KS 66517
(785) 539-0311

City of Wellington 733
Carl Myers
City Manager
317 S. Washington
Wellington, KS 67152
(316) 326-3631

City of Conway Springs 734
Ward Sones
Mayor
208 W. Spring
Conway Springs, KS 67301
(316) 456-2345

C-ME Recycling, Inc. 735
Roger Schneider
4860 W. Crawford
Salina, KS 67401
(785) 825-2818

City of Caldwell 750
Freda Cink
City Clerk
14 West Central
Caldwell, KS 67022
(316) 845-6514

We would like to thank the following magazines for allowing us to reprint these articles:

Lawn & Landscape Maintenance Magazine
"Spinning the Magic Circle" by Rod Tyler, September 1995
"Using Compost Successfully" by Rod Tyler and Ron Alexander, November 1992

BioCycle Magazine
"Composting View, Vertical Route in the Compost Business" by Rod Tyler, March 1997

COMPOSTING VIEW

Rod Tyler

VERTICAL ROUTE IN THE COMPOST BUSINESS

VERTICAL integration is a business growth tactic that both improves the bottom line and can position companies to become much more competitive. Many industries have experienced vertical integration as they mature and today, the leaders of many Fortune 500 companies are totally vertically integrated from manufacturing to packaging and marketing. I believe there are significant trends which suggest vertical integration is beginning to take hold within the realm of organics recovery, especially with composting and wood recycling. Reasons for vertical integration are listed in descending order of importance as viewed by the author.

The compost business is too expensive to exist on its own. Due to the amount and nature of equipment, the compost business necessarily needs to be connected to wholesaling or retailing to maximize profitability. Personnel, too, can be spread out to be more effective.

Existing retail and wholesale outlets are making more money than manufacturers of the products, and it will only get worse when competition increases. The only logical move will be for large retailers/wholesalers to begin composting or for composters to begin retailing. Typical retail and wholesale yards commonly target a 40 to 60 percent profit margin on all materials imported for sales. Are manufacturers of compost targeting these types of returns?

The existing retailer and wholesaler are not as passionate about the value of compost as the compost manufacturer is. Nobody knows the reasons to use compost better than the folks who make it, yet the value is not seen as the same once the product is resold. Employees of resellers do not normally have incentives to make compost sales a priority and for that reason, sales are normally slow the first few years the product is offered.

All organic products are generally generic. Mulch is mulch, compost is compost and topsoil is topsoil — until an enterprising composter, with the exact ingredients, makes compost that consistently outperforms the competition. The same is true for the effect compost has or does not have on other products with which it is blended. Vertical integration offers the manufacturer the option of reaping the rewards of research and development with various mixes which prove to grow plants better. Until such time, generically distributed compost will remain generic, and brand loyalty will not occur.

Shrinking margins. As competition increases, and as producers try to retain their market share, more and more product will drive pricing lower and lower. For a producer to make 30 percent and a reseller to make 30 percent creates a total 60 percent margin in the marketplace from producer to final end user. Eventually, the market will only bear, say, 45 to 50 percent, and the ones who give up their percent profit will be the producers, in an effort to retain long term market share. Since compost is generic, the wholesale trades will buy based mostly on price. As soon as a leader in quality promotes compost effectively, directly to the retail market, they can achieve not only a select niche market, but much higher margins.

As more and more resellers begin carrying a product, the market, in general, becomes familiar with the availability of that product. When colored mulch hit, few dealers carried it, but retail buyers asked for it. As it is with quality compost, they will ask for it too, once they have had a positive experience. The problem is that as all these dealers begin carrying the product, none of them may carry the same product, (ie., if enough choices are available, it confuses the overall market). Therefore, if "the majority of dealers" carry the same product and promote it in the same manner, the buyers see a more singular message and are more willing to believe the sellers sales pitches and remain customers.

Compost fits too well with a natural blend of other products. Landscapers buying hard goods (stone, topsoil, sand, mulch, etc.) utilize 80 percent of their dollars to buy only three products — topsoil, mulch and compost. The top ten moving items at reseller locations are as follows: 1) Topsoil; 2) Mulch; 3) Compost; 4) Limestone; 5) Washed gravel; 6) Fines for paverstone installations; 7) Mason sand or fill sand; 8) Paver stones; 9) Retaining wall stone; 10) Plants — perennials, trees and shrubs; (These are listed in estimated order of importance, from a volume and dollar sales standpoint. Many markets will not even have compost in the top ten product listings.)

For companies who are going to somehow enter the bagging business, vertical integration offers the only direct purchase opportunity for bagged products. It is next to impossible to sell bags directly to the retail sector from a single location. Besides, this would offer direct competition to the large retail chains which would jeopardize purchaser-supplier relationships. However, with ten sites, bag sales could be a large line item on the income statement and collective advertising and promotions would begin to pay off. The only other choice for bag sales is to go through the major retail chains, which offer little profit potential and little loyalty long term. Often, a 5 percent margin is common. This margin can be increased if no middleman is present.

Vertical integration closes the loop. Don't ever forget to play the emotion game. Even in states where the local law has become the local loophole, loyal recycling advocates still want to see what they collect recycled into a usable product. Many of these communities will be willing to bring their materials to a dropoff location at the site — either for free or for a small fee. Smart marketing says if they buy something while they are there, they could dump for free.

Vertical integration is inevitable to some extent in.the composting industry. As sites look to expand and analyze the cost impact of sharing equipment on site or with other related sites across town, the economic benefits become apparent. In the future, look for creative marketing companies — highly successful within the sales arena to "back up the stream" — to begin their own form of vertical integration by getting into the composting business. ■

Rod Tyler, author of 'Winning the Organics Game—The Compost Marketers Handbook", ASHS Press, 1996, is an independent writer residing in Medina, Ohio.

The Future of The Compost Industry...

Spinning the Magic Circle

Effective solid waste management and the growth of the green industry are on a converging course. This "magic circle" of growth and opportunity can benefit both industries.

By Rod Tyler

THE PAST FIVE years have been an organizing and planning time for most solid waste officials and composting has emerged as the preferred method of effectively handling organic residuals. Although the two main sources feeding compost facilities are yard trimmings and biosolids, there is reason to believe that these represent only the tip of the iceberg when the entire palate of compostables is considered.

For that reason, there has been overwhelming fear about a tidal wave of compost that will devastate the market once composting is fully accepted in each community. It has yet to happen, but the potential exists if the markets do not develop along with the producers. For instance, about 200 million tons of solid waste are produced each year, of which about 60 percent is compostable. That will produce about 120 million tons of compost products.

But the agriculture sector — the largest market for compost products — is also one of the largest producers of compostable feedstocks...manure. A total of 1.4 billion tons are produced yearly, a figure that dwarfs all solid waste combined. If and when these materials are composted, there will be plenty of product to go around.

As lawn and landscape contractors expect the production of high quality compost materials, the market will increase and more producers will use the "compost factory" approach. Credit: Rod Tyler

COMPOST ECONOMICS. There are really only two ways to begin composting. Either a program begins as a form of alternative waste management or the market demands organic products so strongly that it justifies producing a product. To justify producing compost strictly from the sales of the product, sales may need to be over $35.00 per cubic yard, even for simple outdoor windrow technology.

The composting industry has grown tremendously over the last five years with the help of the green industry, a natural fit almost too good to be true. As long as gardening fever continues in the retail sector, the demand for compost products will continue to expand in each urban area.

The public has begun to expect to be surrounded by flowers. Compare anywhere you shop today with the same location ten years ago. You'll find more green, more color and more entertainment. In fact, some horticulturists like Rob McCartney from Sea World of Ohio, Aurora, insist that landscaping for entertainment has become a main attraction at their locations. Other locations like parks, restaurants and even corporate centers have put major emphasis on increasing total green space.

Just how much compost can the green industry consume? It is obvious that the first market sector to develop for compost products from urban locations has been the green industry, which includes professional landscape contractors, nurseries, topsoil blenders and mulch dealers.

Quality products will always be welcome at reasonable prices in the green industry. However, the paradigm for producing compost has changed over the last five years in a positive way — toward manufacturing — more than before.

EXPECTATIONS. Sometimes we get what we expect. If we expect to get something out of a compost industry report, we probably will. The same is true for what we should expect from

COMPOST RESOURCES

The following sources can offer information and further guidelines on composting techniques, applications and economics:

The American Society for Horticultural Science
113 S. West St., Suite 400
Alexandria, VA 22314-2824
703/836-4606
This group sponsors two-day seminars on "Using Compost and Other Organic Products" at various sites around the country.

Lawn & Landscape Maintenance Magazine
4012 Bridge Ave.
Cleveland, OH 44113
216/961-4130
Compost article reprints and discount info on the soon to be published Compost Marketers Handbook are available.

Composting Council
114 S. Pitt St.
Alexandria, VA 22314
703/739-2401
Provides the Compost Information Kit and several use guidelines; offers best practices seminars.

the two converging industries. A crucial issue to future the expansion ofboth industries is to keep the positive results of using compost front and center, while limiting exposure to negative experiences.

It is best to consider the composting process as a manufacturing process yielding high quality products. Expect it. This production mentality, or "compost factory paradigm," is in fact the main theme guiding the most successful composting operations today.

The benefit to the green industry is that the products produced by compost factories help to increase plant growth significantly, making the eventual demand in the green industry for landscaping services increase accordingly.

THE MAGIC CIRCLE. The magic circle can be applied to almost any aspect of a contractor's business. Mowing, planting, fertilizing and other activities all have their respective challenges to make sure the magic circle stays closed. If the loop is completed, customers are happy and the industry builds upon its own success.

If the loop breaks anywhere along the line (generally this happens after project completion), the contractor's reputation and the industry's are at stake. As it relates to good compost, the magic circle depicts the need for us to correctly use high quality products capable of providing plant growth benefits.

There are many ways in which incorrect use of compost can break the magic circle. Contractors who use compost incorrectly may produce poor results. Or, they may not be using enough compost for the project at hand.

The magic circle covers projects performed by landscape contractors or do-it-yourself weekend gardeners. These weekend gardeners are becoming more prevalent as the gardening trend increases, but they too run the same risk as contractors in selecting the right product for the right application.

How many potential customers are lost when negative experiences occur from either improper use or low quality of compost? It is hard to say, but the table on page 38 helps define negative experiences as they relate to products or services.

It is evident that both service experiences (product use issues) and product experiences (product quality issues) must be positive to hope for repurchases from customers. Even if the repurchase intent is about 85%, current customers would still be slowly slipping away at a rate of about 15% per year.

These lost customers must be replaced with at least as many "new" customers each year to keep the market the same. Thankfully, it seems that gardening is increasing everywhere we look, at a much higher rate than first projected. But first, compost producers need to take an oath of quality production.

When compost producers accept the production mentality mandated by the compost factory paradigm, they will keep the magic circle fully closed, guaranteeing them a long-term, profitable market. It is in their best interest to produce only the best possible compost.

How do potential compost users know what to expect if they have never used compost? Contractors and their respective clientele will naturally compare results with what is standard or acceptable in the industry. They may also ask someone in their profession.

The consumer will probably ask a local garden center or extension agent. Although most extension agents have been extremely gent to stay informed about compost, it is the garden centers who need to be closely connected to the information highway to make sure the magic circle stays intact for compost users.

WHO'S COMPOSTING? It seems that several kinds of participation are occurring throughout the green industry. Landscape contractors who still generate grass clippings and other yard debris often bring the materials back to "the yard" to be composted.

Unfortunately, unless the volumes generated justify purchasing a small tub grinder, they often do not grind the materials until a sizable pile is accumulated. At that time, they either rent a piece of equipment or hire a custom grinding operation to come to the site and process the material. Either way, the options result in costs of about $4 to $8 per cubic yard of debris, depending on the machinery used.

The common occurrence of a yard debris pile at the contractor's headquarters is now becoming more acceptable, but does not increase the aesthetics of his office grounds. In fact, an unprocessed pile could send negative messages to visiting clients who notice how their service providers take care of their own landscapes.

RELATIONSHIP OF PRODUCTS, SERVICE AND OVERALL SALES EXPERIENCE OF THE CUSTOMER

PRODUCT EXPERIENCE	SERVICE EXPERIENCE	REPURCHASE INTENT
Positive	Positive	85%
Negative	Positive	35%
Positive	Negative	12%
Negative	Negative	1%

Table 1 (Source: Tyler, 1995, after Stanley, 1994)

KNOW YOUR COSTS. In many cases, contractors have opted to channel the yard debris to other commercial composters who already possess the equipment necessary to process the material immediately.

Tipping fees for this type of service are not normally as high as surrounding landfill rates, but can be significantly higher than the contractor may pay for processing the material himself.

It is important to include all the costs associated with each process when considering what to do with all the green debris generated at normal landscape contracting jobs.

For instance, it is easy to leave out labor and management costs associated with processing materials at the contractor's yard, but these costs also have attached variables that must be controlled or problems will arise later.

One example would be grass clippings, which should be processed immediately. But if all the employees are in the field, clippings can be a particularly challenging variable to manage. Yet, they must be managed in a timely manner.

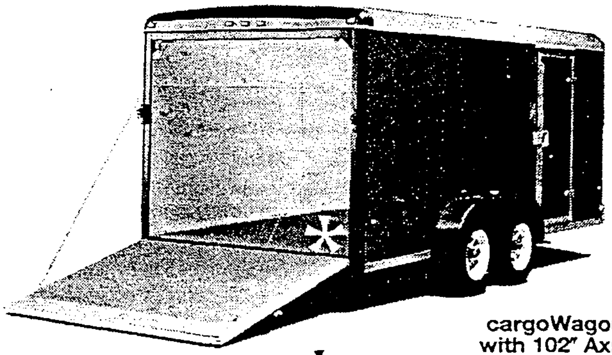
Nurseries are beginning to compost many of their own green residuals, including culled plants and discarded soils from ball and burlap production. For nurseries growing larger stock like shade trees, again the issue of efficiently handling and processing these bulky brush materials becomes perhaps the most challenging issue relating to on-site composting.

Some nurseries use stumps and large brush for erosion control along edges of fields where forests have developed steep ravines. Although this is a good environmental strategy, there are only so many ravines to fill at each nursery and sooner or later, the problem must be faced.

The majority of nurseries have mimicked landscape contractors by hiring grinding crews to come in and process large stockpiles of green debris.

An issue of quality concern usually arises for green industry companies who compost their own materials. For the operators who establish their own composting

(continued on page 42)



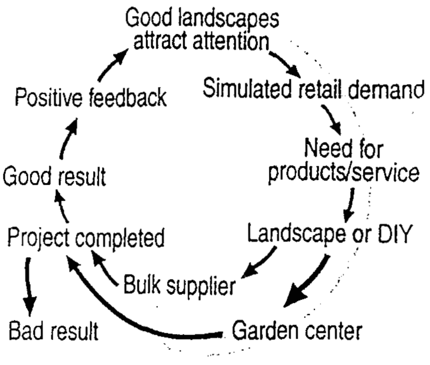
(continued from page 38)

operations, the compost itself is secondary to their core business. This means that many important items needed to generate a high quality compost may be overlooked during the busy season. Items like weed seed destruction may not occur evenly and when the compost is used in the future, it may become a source of problems for weed infestation.

It is clear that local composting facilities in partnership with the green industry have a lot to gain. Integrated programs offer collection of green debris in roll-off containers, semi-trailers or strategically located drop-off sites to make it easy to participate. Some composting companies offer to place roll-off containers at nurseries, with the idea that the landscape contractor already comes there to pick up plants, so they might as well drop off their green debris at the same time.

WHO'S BUYING COMPOST? A recent study identified landscape contractors, nurseries and topsoil blenders as the first markets for products produced by compost facilities. In fact, the study also indicated that compost supply was not enough to keep up with demand in the top 12 urban markets in the United States.

"THE MAGIC CIRCLE"



The "magic circle" shows how the compost and green industries benefit each other.

Collectively, the green industry has the lion's share of the market for compost from private or public sites. Table 2 shows major programs around the country and originated from a study conducted by the U.S. Environmental Protection Agency, focusing on 30 "compost factories." Average price varies from $5 to $10 per cubic yard of compost.

FUTURE OPTIONS. As we look to the future to comtemplate how and when the compost industry and green industry will in fact converge, we cannot help but wonder if this whole issue is somewhat ironic.

The same industry that generates a majority of organic debris in urban areas in the form of yard trimmings is also the industry that is willing to pay the most for high quality recycled organi products. It should be no surprise to learn about some of the programs offered which focus on providing education to both industries. It has been rewarding to finally see these two industries begin to work together toward a more common goal of environmental enhancement.

The compost industry is quite active in doing something about keeping the magic circle healthy. The Composting Council, located in Washington, D.C., is dedicated to promoting the development of composting and recently completed a "Compost Information Kit," which is available to anyone interested.

The kit includes a large wall chart about making, using and selling compost products and what a vendor should consider before building a composting facility. It also has a compost calculator, or slide rule, which shows how much compost is needed for various depths and for area measurements.

The Council is also promoting the magic circle by offering best practices training sessions to teach enterprising composters how to achieve that magical level of quality which all marketers dream about. The seminars provide technical insight into making compost and how to troubleshoot known pitfalls that have popped up on compost site failures in the past.

"Use guidelines" for the most popular compost uses in the green industry discuss using compost for flower bed preparation, as a garden

(continued on page 44)

Compost

(continued from page 42)

amendment, as a mulch, etc. They are based on sound research and have a tremendous amount of science behind them.

There seems to be no better place to properly mix the compost industry with the green industry than at major theme parks, zoos and other highly attended public facilities.

The opportunities that could be created by promoting lavish landscapes installed with compost are limited only to the imagination. The trend of "landscaping for entertainment" will surely increase, providing impetus for stimulating more retail demand and driving the magic circle around again. Hopefully, efforts to close that loop will keep the compost and green industries alive and prosperous. ■

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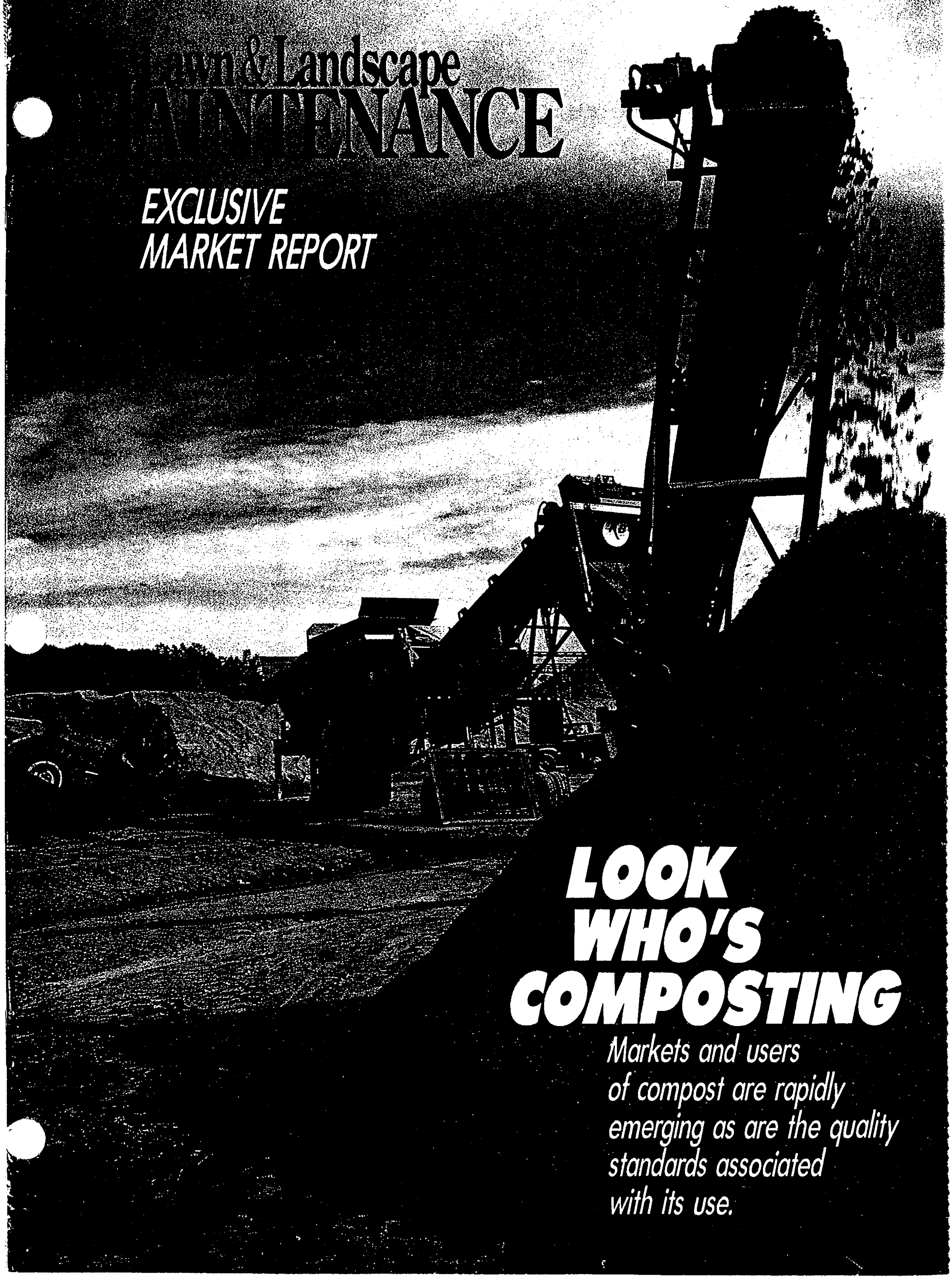
COMPOST/MULCH END PRODUCTS

COMMUNITY	END PRODUCT	END USER
Akron, Ohio	Compost	Landscape, residents
Austin, Texas	Compost	Landscape, retail
Berkeley, Calif.	Compost, mulch	Wholesalers, nurseries, residents
Berlin Township, N.J.	Compost	Residents
Boulder, Colo.	Mulch	Residents, public facilities
Bowdingham, Maine	Compost	Residents
Columbia, Mo.	Mulch, wildlife habitat	Residents, landscape contractors
Dakota County, Minn.	Compost, mulch	Residents, landscape
Fennimore, Wis.	Compost, farm application	Farmers
Hamilton, Ohio	Compost	Landscape, residents
King County, Wash.	Compost, mulch	Privately marketed
La Crescent, Minn.	Compost	Residents
Lafayette, La.	Compost for Public facilities	Public facilities
Lincoln, Neb.	Compost for landfill, mulch	Landfill, landscapes
Lincoln Park, N.J.	Compost, mulch	N/A
Mecklenburg County, N.C.	Compost, mulch	Residents, landscape contractors
Monroe, Wis.	Compost	Residents, public facilities
Naperville, Ill.	Compost, mulch	N/A
Newark, N.J.	Compost, mulch	Rutgers Univ. urban gardening, businesses
Perkasie, Pa.	Farm applications, mulch	Landscapes, farms
Peterborough, N.H.	—	—
Philadelphia, Pa.	Compost, mulch	Residents, landscapes, public gardens
Portland, Ore.	Compost, mulch	Residents, landscapes nurseries
Providence, R.I.	—	—
San Francisco, Calif.	Compost, mulch	Retail and residents
Seattle, Wash.	Compost	Retail and wholesale
Sonoma County, Calif.	Compost	Landscape, residents, farmers
Tacoma Park, Md.	Compost, mulch	Residents, garden shops
Upper Township, N.J.	Compost, mulch	Wildlife habitat, county, residents
Wapakoneta, Ohio	Farm application	Residents, farmers
West Linn, Ore.	Compost, mulch	Residents, public facilities
West Palm Beach, Fla.	Mulch	Residents, landscape

N/A = Not available
— = Not applicable

Table 2 (Source: Adapted from EPA 530-R-92-015, 1994)

Lawn & Landscape
MAINTENANCE



EXCLUSIVE
MARKET REPORT

LOOK WHO'S COMPOSTING

Markets and users of compost are rapidly emerging as are the quality standards associated with its use.

Using Compost Successfully

Landscape contractors and their customers will require proof of high quality, environmentally safe products before purchase.

Composts of various quality and characteristics have been used in numerous applications, but what type of compost is really best for you and the properties you're managing?

By Ronald Alexander and Rod Tyler

Composts are being produced out of many feedstocks with the use of various bulking agents and under various environmental, chemical and biological conditions. Consequently, finished composts exhibit a range of characteristics and varying qualities.

It is important that compost manufacturers, marketers and end-users understand this variability exists, and that individual composts possessing specific characteristics are more likely suited to specific applications under specific conditions. Understanding these facts can help manufacturers produce higher quality composts, marketers distribute their products to the appropriate end-users and end-users purchase and use the compost products best suited for their specific use.

In order to better address this concept, we will describe the major markets for compost use, including landscaping, nursery growers and sports turf, offer an explanation of product uses within each particular market and outline the desired compost characteristics for those uses.

LANDSCAPERS

Landscapers have been using composted products for many years and in many applications. So it should be no surprise that landscapers are currently using large quantities of composts produced from various municipal and agricultural wastes. Composts of varying qualities and with varying characteristics have been used in soil upgrading; turf establishment and maintenance; mulching; and in the establishment and maintenance of ornamental plants.

The type of compost used by an individual depends on product availability, the specific application and customer preference.

SOIL INCORPORATION/UPGRADING. Compost is an excellent amendment for soils low in organic matter content, those suffering from poor nutrient retention properties, highly compacted soils or those lacking water holding capacity. The addition of compost improves the soil both physically and chemically, allowing for healthy growth of turf and ornamentals.

Research has shown that the application of sludge compost at a rate of 260 metric tons per hectare (approximately 235 cubic yards/acre) enhances the establishment of turfgrass from seed. The application of 180 metric tons per hectare (approximately 160 cubic yards/acre) of compost was adequate for the establishment of turfgrass sod. In experiments, compost significantly improved the rate of establishment and general appearance of the turfgrass (Angle 1981).

The application of a 1- to 2-inch layer of compost is often cited as a general application rate for upgrading soil for the establishment of turf from seed or sod. This layer of compost should then be incorporated to a depth of 5 to 8 inches for maximum effectiveness.

Compost used in soil upgrading should be rich in organic matter (more than 50 percent), free of weed seeds and possess a texture and moisture content allowing for easy spreading.

Most states have legislation governing landscaping loading limits for various fertilizer and organic materials. Chemical analysis of composts will be required to satisfy these laws. The pH and soluble salt content of the compost depends on the characteristics of the soil being amended and the plant materials to be established.

In turfgrass situations, these characteristics are not as critical as when improving a garden area for annual or perennial plants. In these latter applications, the soluble salt content of the compost is significant in that excessive levels in the soil mixture may be damaging to certain species (i.e., geraniums and asters).

It has been shown that various annuals and herbaceous perennials respond favorably to compost applications at a rate of 10 percent to 30 percent of a garden soil mixture (Smith 1991). A 1-inch application rate of compost tilled to a depth of 5 inches is a 20 percent inclusion rate. It is also important that compost used in this manner is stable (well cured), so that nitrogen immobilization does not occur.

Higher quality and more refined composts, up to this point, have proven to be more popular in soil incorporation projects for garden areas and on home lawns. Less refined products, such as composts containing foreign matter and ones which are odorous, are more acceptable in commercial and/or industrial applications.

Using backfill mixes with 10 percent to 30 percent compost improves the performance of trees in the landscape environment.

TOPDRESSING. Topdressing has long been a reliable turf maintenance practice in the golf course industry and has grown in popularity for commercial and home lawn applications. The practice entails applying a thin layer (approximately 1/8- to 1/2-inch) of topdressing material over an established and usually declining turf area. Topdressing is usually done in conjunction with aeration and reseeding.

Compost used as a topdressing must not only be consistent in its chemical characteristics, but also in its physical characteristics. The materials used must have a texture making it easy to handle and one that is finely screened. It must also be free of foreign matter and objectionable odors, since much of the material will be left on the soil surface.

This market is expected to grow with the popularity of low input landscaping and/or maintenance practices which use organic materials. The chemical and biological characteristics of compost have also been suggested to improve the degradation of thatch which may be a nuisance in some established turf areas.

PLANTING MIXES. Composts have been used as a component of various landscape growing mixes such as those for roof tops, raised planters, planter boxs and backfill mixes. These mixes may include topsoil, peat moss, sand, styrofoam, vermiculite, perlite and compost usually at a rate of 25 percent to 33 percent of the mixture.

Compost in these applications will improve drainage and water holding capacity of the mixes, encourage deep rooting and will supply a rich source of organic matter and nutrients. The organic matter supplied by compost will also increase the cation exchange capacity of the mix and supply valuable humic acid, which aids plant uptake of some nutrients. The compost used in these applications must have a pH and soluble salt content which, when mixed with the other planting components, are acceptable to the growing plants. This material must be weed free, have a workable texture and must be stable to avoid nitrogen immobilization.

MULCHING. Some composts have been successfully used as a decorative mulch in garden beds. They are usually applied to the soil surface at a depth of 2 to 3 inches. Compost mulches are used to conserve moisture, lower soil temperature, reduce erosion, provide nutrients and discourage the establishment of weeds.

The compost must have a uniform appearance, possess a dark color and should readily absorb moisture. The compost must also be free of weed seeds and have a pH and soluble salt content which will not negatively affect the growth of the plant materials being mulched. Composts produced from both sludge and leaf/yard waste are currently being used successfully as decorative mulches, while composts produced from municipal solid waste have not been as popular in this application because they often contain foreign matter, giving it a non-uniform appearance.

SPORTS TURF

Each year a tremendous and ever growing amount of acreage is maintained as sports turf. New golf courses continue to be built as the popularity of the game increases. At the same time, the popularity of many other field-played sports has forced the construction of new fields and has increased the use intensity of existing fields. Compost used in the construction and maintenance of sports turf has both a proven track record and bright future in this market.

The golf course industry has a great appreciation for the importance of organic matter and for this reason the use of many composted products is commonplace. New uses for compost on golf courses are also gaining momentum, but have not gained total acceptance by this conservative industry. The most popular of these uses are discussed below.

TOPDRESSING. This market niche is slightly different than previously noted in the landscape section. Golf courses historically have less margin for error in the maintenance of turf as a result of high intensity management programs. Therefore, the compost products used in topdressing mixes will normally be of high quality, possess a high organic matter content, a low odor potential and be low in heavy metals and soluble salts.

Composts used in topdressing mixes may have a pH of six to eight and will need to be fully mature with minimal inert contaminants. Particle size of compost used for topdressing should be less than one-quarter inch since most mixes are screened at least to this size.

Typical topdressing mixes for golf courses are comprised of 70 to 90 percent sand and organic material. Peat moss is the reliable organic standard, but some research indicates compost may be an acceptable substitute (Nelson 1992).

Fairways, although not currently topdressed as frequently as greens, comprise the largest potential percentage of the total topdressing budget. Golf courses have used finely screened compost alone as a topdressing on fairways, or as a component in a mix.

The future for compost use through topdressing mixes looks extremely promising. Early research indicates compost may have disease suppressive properties. Therefore, future topdressing programs may use funds from current disease control budgets giving increased value to

STEP-BY-STEP
USE OF COMPOST ON ATHLETIC FIELDS

→ TOPDRESSING

1. Heavily core aerate entire athletic field, concentrating on most heavily trafficked areas.
2. Apply approximately a half-inch layer of compost or 50/50 sand/compost mixture. The most uniform and efficient way to apply the compost is with a topdressing unit or manure spreader.
3. Smooth the surface using a raking device or using a weighted drag mat. The raking/dragging will break up the soil plugs, mix it with the compost and backfill the holes.
4. Seed and water the topdressed area. It is important not to leave the grass seed on the soil surface. It should be mixed into the soil/compost layer.

→ RENOVATING

1. Mechanically till the entire field, turning the soil and destroying the remaining vegetation. A rototiller or farm disk are the best pieces of equipment to use. Killing the existing turf cover with a non-selective herbicide may be worthwhile if weed infestation is significant.
2. Apply two to three inches of compost over the entire field. More product can be used in areas on the fields which have received the most wear. (e.g., center of football fields).
3. Incorporate the compost into the field to a depth of six to 10 inches. Normally, the deeper you can incorporate the product, the better. Work the soil until it is thoroughly mixed and clump free.
4. Shape and smooth the field using a raking device. Firm the field using a light roller. Establish a crown on the field if desired.
5. Seed and water the field. Make sure the seed is incorporated into the top one quarter inch of modified soil.

→ CONSTRUCTING

1. Using front-end loaders or other bulk blending machinery, manufacture your field mix. To ensure uniformity, manufacture the mix in small, controllable batches. Mixing should be done off the construction site.
2. Spread the athletic field construction mix using a grading blade over the entire field, starting from the center of the field and working out. For optimum results, the mix should be spread to a depth of 12 inches.
3. Shape and smooth the field using a raking device. Firm the field using a light roller. Establish a crown on the field if desired.
4. Seed and water the field. To improve seed germination, incorporate the grass seed into the top one-quarter inch of construction mix.

Source: Ron Alexander

Table 1.

compost products offered to support this avenue of golf course management.

CONSTRUCTION MIXES/RENOVATION. The same general guidelines for product quality apply to golf course construction mixes, although larger amounts of product are used more quickly, especially in whole course construction. As many as 250 to 500 yards of a mix may be used for each green, indicating a large initial outlay of compost for an 18-hole course. Additionally, greater amounts of compost can be used in bed preparation and landscaping of the grounds. (Refer to the landscape section.)

ATHLETIC FIELDS. As the desire and need to create more resilient, more attractive and safer athletic fields has increased, so too has the need grown for an inexpensive, versatile product. The need for an organic product which can be used in the maintenance, renovation and construction of athletic fields will help fill this void, and help a market strapped by shrinking budgets.

As discussed earlier, the addition of compost to soils high in sand or clay content will improve the structure and friability of the soil. The use of compost will also improve the drainage in athletic field soils, and the addition of organic matter will slow the rate of compaction. The use of compost in the maintenance (topdressing), renovation (soil amendment) and construction (mix component) is explained in more detail in Table 1 (Alexander 1991).

The use of compost on athletic fields will continue to grow as long as the product stays price competitive and consistent in quality compared to peat moss and commercially available topdressings. Compost used in athletic field maintenance (topdressing) must fit the specifications outlined earlier in the landscape section. Again, the material must also be finely screened in order to be easily backfilled into aeration holes, and so as not to smother existing growth.

The compost must be mature and free from significant foreign matter since traces of the material may be visible on the soil surface. Compost used in the renovation or construction of athletic fields may be slightly coarser than material used in topdressing.

Compost screened through a three-eighths to one-half-inch screen is acceptable for use in the renovation and construction of athletic fields, while materials used as a turf topdressing should be screened through a one-fourth to three-eighths screen. Compost used in the construction of athletic fields must have a texture which allows it to be easily mixed with other athletic field mix components like silica sands. Ratios and possible combinations of topdressing mixes are determined on a case by case basis, depending on native soil test data.

Material with a moisture content of 55 percent or more may be difficult to spread or mix efficiently. Since the majority of athletic fields are located at heavily populated schools and universities, the use of materials with objectionable odors or a significant amount of foreign material is not recommended.

TOPSOIL BLENDERS

Topsoil blenders are not actually an end-market for composted products because most materials produced are sold to other green industry professionals that use the soils. Landscapers, garden centers, nurseries and homeowners are often the end-markets where compost products end up after being professionally blended by a topsoil company. Many believe that the future of topsoil blending lies in the manufacturing of special blends to suit specific growing needs of specific plant families.

Adding compost to soils usually reduces potential runoff and erosion (Kashmanian 1992). Urban soils in most major metropolitan areas have had their soil structure destroyed from pulverization or multiple handling by large equipment (McCoy 1990). Research has shown that the addition of organic matter to these soils in a blending situation helps the resulting mix set up new structure when placed on the job site.

Recommended additions of compost to soils can vary greatly depending on what types of soils are used, however, a general guideline of 20 percent has been shown to be effective in the lab and field (McCoy 1990). Many composts also exhibit a wide particle size distribution which may or may not be beneficial in a blend, depending on the objective of each mix.

Composts used for topsoil production theoretically may be coarse as long as the final mix is screened. If a blend is made without final screening, compost should be supplied as three-quarter-inch or less in particle size. Heavy metals are less of a concern for horticultural applications. However, considering that many homeowners will purchase products for vegetable production, safety standards for food chain production should be followed.

Organic content should be consistent with the source of compost (i.e., if the feedstock materials do not regularly change, the end-product should be consistent in organic matter content). Changing compost sources midseason may alter blended topsoil appearance and create market confusion unless creative blending measures are taken.

Compost needs to be fully mature and low in soluble salts for most soil blend end-markets. The pH of composts used in blends may vary from six to eight. The pH of the final soil blend will depend greatly on the buffering capacity of the soil and the pH of ingredients. Many current topsoil mixes are manufactured to meet growing specifications per plant family, and pH may be adjusted accordingly by adding lime or ammonium sulfate.

SPECIAL BLENDS. There is a growing demand for special blends of soils for all types of horticultural applications. The specialization trend taking place across the United States is also predicted to occur in growing medias as well. The concept of offering blueberry mixes, azalea mixes, annual mixes, perennial mixes, etc., for future markets is very strong. However, the amount of research and documentation that needs to be done to support these budding markets is vast.

Currently, landscape architects specify potential compost products in their plans for new construction based on their knowledge of growing medias and the existing soils. It is vitally important that any new mix be studied and the addition of compost to this mix be compared to a standard such as peat moss, hardwood bark, etc.

Because many state laws mandate composting yard waste, sludge and other organic medias it seems only natural that local blending and specialized custom blends will some day be a large market for compost products.

Criteria for compost used in this market sector is highly variable with respect to pH and soluble salts due to the variable responses of plants. However, it is likely that consistent, mature, medium-textured composts with little or no inert contamination will be ideal for marketing through special blends.

RECLAMATION

The reclamation and revegetation of highly degraded sites is an excellent use for compost. Compost has been used with great success in the reclamation of strip mines and sand/gravel pits, and in the closure and vegetation of landfills. Compost has unique chemical, physical and biological characteristics which make it well-suited for use on sites that are difficult to re-establish with plant life. Compost has even been used to remediate soils which have been polluted and were unable to sustain plant growth. This market also shows a great potential as a means to use lower quality compost.

STRIP MINES/SAND AND GRAVEL PITS. The potential quantities of compost used in renovating of surface mines, sand and gravel pits is tremendous. Compost can be used as a soil amendment at a quantity of 250 to 500 cubic yards per acre (approximately 2- to 4-inch layer) in order to help support vegetative growth. This vegetative growth stabilizes the soil surface and reduces the chance of soil erosion and runoff.

Previous work has shown that the use of sludge and other composted products applied in a large one-time application can be used to revegetate abandoned mines (Sopper 1991). Vegetating abandoned mine sites may be difficult because high levels of contaminants often found at many sites are toxic to plant growth.

In sand and gravel pits, the physical characteristics of the site may also make it difficult to vegetate. These sites are often low in organic matter and have a low water holding capacity, buffering capacity and cation exchange capacity.

The addition of organic matter, such as compost, improves these characteristics making the area habitable for vegetation and soil biota. When applying compost to mine sites in which high levels of heavy metals exist, the addition of compost has been shown to help "tie up" these contaminants, making them less available for plant uptake and allowing healthy plant growth.

A dense vegetative cover may also reduce the chances of heavy metal transport through surface runoff. These sites are considered to be a nuisance and have long been ignored in the past. Keeping this in mind, and knowing that these sites are not easily accessible to the public, it seems feasible that even low quality composts could be used in the renovation of these sites. Even compost containing large quantities of foreign material, excluding large quantities of film plastic, are probably acceptable for use.

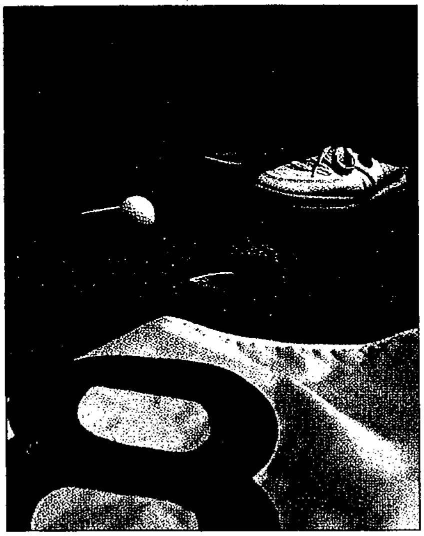
Film plastic may remain on the soil surface and be ingested by animals. Compost which contains a large amount of weed seeds and is considered unstable may also be acceptable for this use. In this application, any product that is low in cost and rich in organic matter is acceptable. Large quantities of compost have not been used, to date, on either of these types of sites because of economic, regulatory and environmental constraints.

LANDFILLS. Compost has been used successfully in landfill reclamation, closure and in daily cover. Many special mixes have been identified, used and tested, including a compost/sand mix, compost/soil mix and compost alone. Although quality control may be slightly less important for landfills, the compost still has to be of high enough quality to support plant life. After all, establishment of vegetation is a key objective for final closure of landfills.

Some municipal solid waste composting companies have planned from the outset to use their compost as daily cover in adjacent landfills and have opted not to take an aggressive marketing approach. This strategy works well because by composting the organic fraction of the solid-waste stream, a large volume of solid wa can be diverted from the landfill. The composting process itself will then significantly reduce the volume of that organic material through biodegradation. As a result, this strategy can extend the life of the landfill and create a ready market for municipal solid waste composts.

Consulting engineers can usually lend a hand in identifying and quantifying slopes so that compost mixtures used for closure can be mixed accordingly. Compost still should be mature enough to support plant growth, low enough in heavy metals to meet state standards and possess physical properties which allow it to be easily spread or blended.

Composts which do not support vegetation may be used for daily cover or mixed with other material such as sand or soil and then used as daily cover depending on state regulations.



Compost is normally used in containers at 10 to 30 percent (top), and can provide many benefits. Golf courses are considering increased disease suppression by using compost as an organic component in blended topdressings (bottom).

NURSERY GROWERS

Greenhouse, container and field nursery growers have a long history of using composted products, such as wood barks, peat moss and various other organic amendments in the production of their ornamented crops. Because research has shown that composts of various feedstocks perform well in conjunction with these products, its use in commercial operatic has grown.

Compost has proven to be a cost benefit to growers in that it can often be purchased at a lower cost than other organic amendments used in the industry. Compost manufacturers have proven that they can produce a product which is of high enough quality and which is consistent enough for use in this industry.

The quality and consistency of the product used by growers is important because of the valuable crops they grow and because these crops are grown in a closed system.

GREENHOUSES. Greenhouse growers have been using more composted materials since the industry shifted toward using soil-less growing media several years ago. Compost is used as one of the organic components to soil-less mixes, usually at a rate of 10 percent to 33 percent of the mix depending on the crops being grown. A significant amount of research has been performed demonstrating the use of sewage sludge compost in potting mixes; therefore, composted sewage sludge is probably the most popular compost used in growing operations.

Compost has also been used because it is a local, high quality source of organic matter and is usually less expensive than other organic components used in growing mixes. The compost used by growers must be very consistent, stable, have a pH preferably between 5 and 6.5, be low in soluble salts and free of weed seeds.

Compost has been found to contain naturally occurring disease suppressive properties which have the ability to help control many soilborne diseases. Because growing mixes are often adjusted to suit the pH needs of the crops being produced, compost which has had lime added to it during the production process is often not used. The addition of lime to compost makes it much more difficult to buffer (its pH), and the use of this material may cause trace elements in the growing mix to be immobilized (Gouin 1992).

CONTAINERS. Compost has been widely used in the production of container-grown nursery stock. Normal compost inclusion rates vary but, generally, a 10 percent to 30 percent inclusion rate is average. It is imperative that any extra labor required to add compost as an additional ingredient to the container mix be offset by savings in the overall cost of the mix. Research with sludge compost indicates a good success rate in the replacement of peat moss in the production of woody ornamentals (Smith 1990).

Some suppression of disease associated with the production of specific plant species has also been documented when compost has been added to container medias (Hoitink 1986). Although market potential for large volumes of compost used through container production is not great, it does represent a specific niche market that may be capitalized on through successful marketing programs. The possibility of providing special pH and nutrient adjusted composts as organic amendments to container mixes may be a very specialized area for future market development.

Using compost successfully in container medias includes using medium to coarse, well-drained, low soluble salt, mature composts. Due to the hands-on nature of many container operations, contamination of composts with inerts will not likely be tolerated in the marketplace. Composts have been known to add valuable micronutrients and improve plant vigor due to water retention properties. However, dangers of rapid material decomposition and shrinkage also exist which may create slow draining, anaerobic growing conditions if mixes are improperly formulated.

Various feedstocks of organically compostable materials with various chemical and physical properties requires a greater understanding of quality control.

FIELD. Field nursery growers are currently using compost in two ways: field incorporation and mulching. These methods are discussed below.

Nurserymen are a significant market for composts, but are quite geographically dependent. For instance, Ohio has an approximately $1 billion nursery-related business compared to other states with limited nursery production.

Field-harvested nursery stock (ball and burlap) remove significant amounts of soil mass and nutrients. As much as 50 to 250 tons of soil per acre may be lost at harvest (Tyler 1991). Additionally, the normal soil loss from erosion makes replenishing the soil (and especially organic matter) a necessity to maintain productivity.

Often, farmers will take their fields out of production in order to grow a cover crop, a vegetative cover which is plowed into the soil, in order to return valuable humus and nutrients back to the soil. This loss is estimated at just under 3 billion tons per year for all agricultural erosion, or about 6.7 tons per acre, per year (Kashmanian 1992). Losses in the nursery may be slightly less due to reduced tillage practices over the life of each crop. Costs associated with using compost cover cropping are competitive when all factors are considered (Logsdon 1991).

Applications of 2 inches of compost, plowed to a depth of 6 to 8 inches significantly increases organic matter in native soils. Native clay soils break up easier and form new aggregation as organic matter decomposition takes place. Sandy soils generally hold 25 percent of their weight in water while many composts hold up to 180 percent of their weight in water (Seattle 1990). Consequently, sandy soils retain more moisture with additions of compost and give plants a better chance for survival during drought conditions.

Compost applications profitably replace normal cover cropping at nurseries by allowing applications, tillage and planting of a new crop to occur in a short window of time. Approximately one full growing season can be saved by using this approach, and the amount of organic matter returned to the soil is at least 10 times the amount delivered by cover crops (Tyler 1991).

Compost used in field incorporation programs must be fully mature, high in organic content, low in heavy metals and low in soluble salts. Concerns with heavy metals usually arise when the land may be used for future food or animal production.

The level of acceptable contamination of the compost with inerts will depend on what loading limits are acceptable to nurserymen using multiple applications. However, since most field crops have growing cycles of two to seven years, a buildup of inert materials in their soils is less likely to occur than fields receiving yearly compost applications.

The pH of a compost may be adjusted after application to suit specific needs for various families of crops or soils. Many nurserymen prefer a coarse grade product because of the resistance to decomposition over time, which helps increase field soil friability and provides adequate aeration for tender roots.

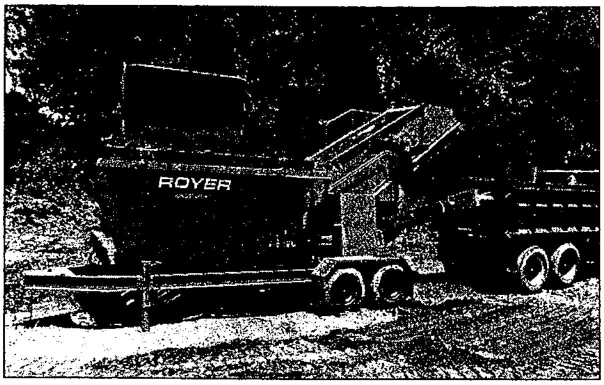
Nurseries can use large quantities of compost by mulching plant rows in field situations. Applications usually range from 1 to 2 inches. Mulch primarily conserves moisture, but also helps reduce weed growth, reduce soil temperatures and eventually add significant amounts of organic matter to the native soils when incorporated into the soil post harvest. This is especially handy when another planting is planned for the same field immediately after harvest.

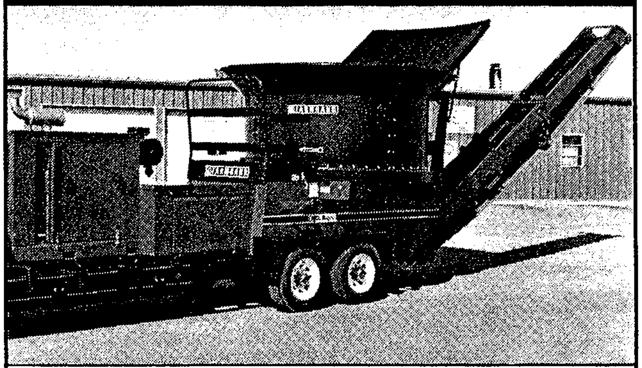
Compost used for mulch can be coarse, but must still be able to be worked in and around individual plants if needed. Nurserymen have noticed using compost as a mulch in place of normal hardwood bark mulch has increased growth and reduced injuries to plants associated with stringier hard-wood bark mulches. Compost processed with a 2-inch screener works especially well (Hendricks 1992).

Heavy metals need to be within acceptable food chain levels unless the land is never again intended to be used for food production. Organic contents should be high to aid in the absorption and conservation of water. The compost should be fully mature and may possess a slightly elevated level of soluble salts due to the high leaching potential of mulch. However, many salt-sensitive crops such as those planted as bare-root cuttings, may react negatively to high salt levels. The pH of the mulch will also depend on the needs of the individual crop being cultivated, but generally may be between six and eight.

ROADSIDE

The use of compost on roadside development and maintenance projects continues to grow as more waste derived composts are produced. Composts are being "specified" as "approved equals" to other organic products such as topsoil or peat moss used in these projects. The need to create markets for the large volumes of waste-





derived composts being produced have lead some states to develop research programs aimed at determining the optimal methods for using compost on roadside projects.

The roadside environment is often hostile. Lack of irrigation, minimum fertilization and the use of road salts often makes it too difficult for vegetation to persist. The use of compost can improve the environment for roadside vegetation, giving it a better chance of survival.

Currently, compost is being used on roadsides as a soil amendment in the establishment of planting beds and as a component of backfill mixes for trees and shrubs. In several states, compost is included to improve the organic matter content of soils used on roadside construction projects, or similarly, in the production of manufactured soils used for the same purpose.

In Europe, compost has been accepted as the growing media in "living walls" which border roadsides and have been shown to perform well in sound minimization. Compost used in these applications should meet the specifications described earlier, for similar purposes. However, characteristics which affect product handling, such as moisture content, may not be as pertinent in projects where mechanical equipment is used to apply and incorporate the compost.

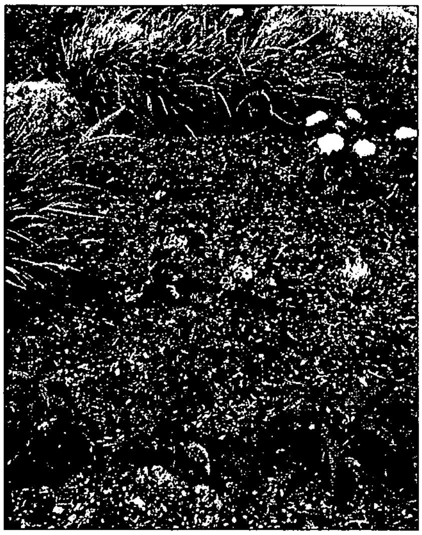
Additionally, characteristics which deal with aesthetics, such as foreign matter content and color, may not deter use — especially if the product is used as a soil amendment rather than for surface application.

The application of compost for weed and erosion control on roadsides warrants more discussion because of the promising results being documented on an ongoing basis.

WEED CONTROL. In many states, coarse composts are approved for use on roadside maintenance projects as a mulch for weed control. Even though the materials are high in organic matter and hold moisture well, they have also been found to be effective in controlling weed growth. This is probably due to the dark color of the products which absorb heat, causing its' surface to readily dry out (Kilbourn 1991).

This hot, dry surface makes it difficult for weeds to establish and, as long as the product is properly composted before its use, the compost itself should be weed-free. Compost used in this application should be coarse in texture, weed-free and low in inerts, as well as aesthetically appealing. The product should also possess characteristics which make it easy to handle and spread. It is possible that the product could be mechanically blown onto areas that are difficult to access (i.e., steep slopes).

EROSION CONTROL. Compost may also be used as a surface application to slopes and embankments in order to control erosion. Once again, coarse composts have been shown to work well in this



Compost used as a mulch for landscape plants during a research at The Ohio State University.

application as have some municipal solid waste composts because of their absorbent nature. Coarse, sludge-based composts (containing a high percentage of wood chips) have shown excellent results applied as a surface application on 2:1 slopes (Rattie 1992).

A mixture of coarse compost and sand, used in similar conditions, has shown similar results. The erosion reduction capabilities of this mix have been attributed to its ability to allow for improved water infiltration. The erosion controlling effects of coarser composts, applied as a surface application, have been attributed to the ability of the product to "knit together," creating excellent coverage over the soil surface and having the density and physical structure which resists surface erosion.

According to research, the addition of compost reduces erosion in three ways (Tietjen 1969). First, soil structural strength is increased leading to heightened resistance to erosional forces. Second, the compost mulch near the soil surface absorbs the energy of raindrop impact and third, soil water holding capacity is increased, providing less water for runoff (Tietjen 1969).

In both weed control and erosion control, further research is and will be required to prove theories regarding the effectiveness of these products. Compost used in erosion control should have similar characteristics to products used in weed control, except for one major difference— its ability to grow vegetation.

In specific applications, where erosion control is desired, a compost which is considered unstable or contains substances which may be detrimental to plant growth, may actually prove to be a benefit in this application. However, in many erosion control practices, the growth of weeds on the soil surface may not be considered negative in that the most practical and effective method for controlling erosion is by densely vegetating the soil surface.

GROWTH MARKETS

Although there are many other potentially large markets for compost use, two in particular may prove to be the most important to develop as more organic residuals are transformed into compost. Both the agricultural sector (food production) and the general public are large potential markets for composts of various feedstocks.

The potential acreage and resources controlled by these groups may make them the key to solving our country's solid-waste management situation. Composting will be used as a means to manage a large portion of the residential, commercial and agricultural organic waste stream. The industry's growth will be closely related to our success in developing large, long-term markets for the resultant products.

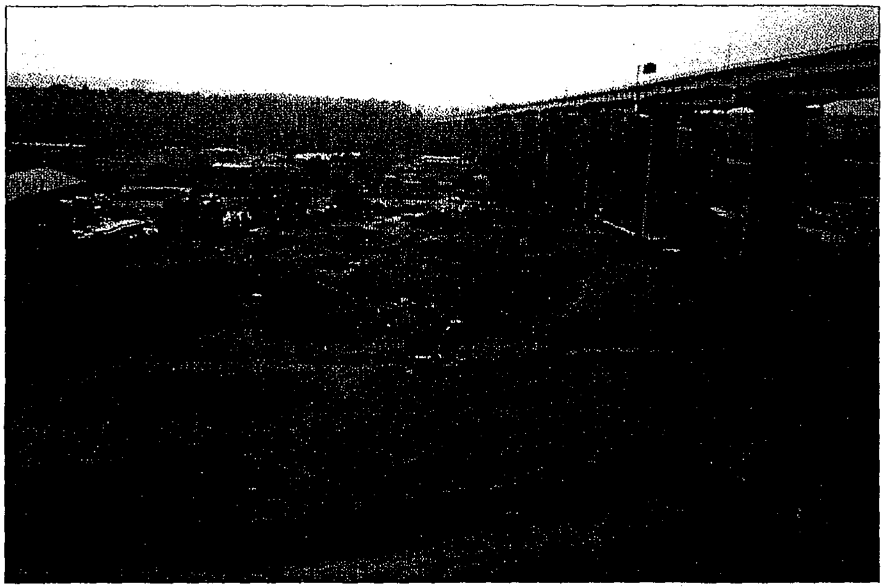
AGRICULTURE. The agriculture market has been considered by some to be the "dumping grounds" for composts which are not of the highest quality. It should be noted that farmers are usually in tune with their soils, often working with agronomists to determine fertilizer loading capacities, etc. Although many perceive that composts used by this market sector may be lower in quality than in other sectors, lower quality products which contain inert materials (i.e., glass, plastics, etc.) will be more recognizable in soil over time. Whether American farmers will allow this to take place is yet to be seen.

Market potential in agriculture is by far the largest (Slivka 1992), but many farmers are also turning to composting as a safe way to handle conventional farm wastes. Given the option, it will be interesting to see whether a farmer will produce his own compost or buy (or be paid to receive) compost produced from waste products.

One thing is for sure, the value of compost when used in sustainable agriculture proposals is significant. It may also be possible to reduce traditional fertilizer and pesticide applications due to benefits associated with composts.

Composts used in agriculture must be safe enough to avoid permanent contamination of soils with inerts or heavy metals. Some composts may be applied in an immature state, however, they are usually less effective than fully mature composts. It is wise not to plant immediately following the application of immature composts due to nitrogen immobilization or low oxygen concentrations that prevail in soil immediately after incorporation of such composts.

The use of composts in agriculture has been shown to offer a variety of benefits, one of the largest being reduction of erosion (Kashmanian 1992). High intensity farming erodes valuable topsoil faster than it can accumulate naturally (Kashmanian 1992). By adding compost on a regular basis, farmers can maintain healthy soils and remain profitable.



Topsoil blends have become a highly specialized market to address individual growing needsof various families of plants.

Loading limits need to be established for agricultural uses of all types of composts with respect to macro- and micronutrients, heavy metals, salts and inert contaminants. The potential amount of compost generated from source separated organic wastes, about 180 million tons, is dwarfed by the amounts of farm manures (and, therefore, possible compost) which may be produced. About 1.4 billion tons of manure are disposed of annually (Kashmanian 1992).

Although many studies have been performed illustrating the benefits of compost use on agricultural land, the market still refuses to pay high costs for these materials. In general, normal farming practices can deplete more than 50 percent of a native soil's organic matter over time (Lucas 1978). Also, losses of humus and other soil nutrients from erosion are significant in agriculture, but compost can help replenish these by being added on a regular basis.

Studies show that the regular application of raw agricultural materials, such as manure, do not readily change the organic matter content in soil over many years (Lucas 1978). Soil humus is lost on a regular basis to soil erosion and soil micro flora, and is also converted to carbon dioxide and water through natural processes. In the United States alone, 3.6 billion metric tons of topsoil are lost to erosion annually, some of that being natural humus (Lucas 1978).

Most farms, in an attempt to rectify soil losses from erosion, land apply the majority of their manures. However, many of the manures currently being applied may contribute to non-point source pollution because they are more easily eroded and leached than products which are composted prior to application.

Composted manures and farm wastes may help reduce non-point source pollution by converting nutrients into less leachable forms.

Compaction may be reduced by the addition of compost or organic matter to the soil, thus helping reduce runoff and erosion from farm fields. Depending on application rates, the addition of compost to agricultural lands can increase organic matter dramatically, whereas applications of raw manures or green manures usually add less total organic matter.

Benefits associated with the addition of compost to agricultural fields seem to far outweigh the extra effort and associated costs. However, an educational system is needed to lead the way for market development in this large area.

By looking at compost products as natural resources which can be used to help offset losses of soil from erosion, we cannot forget that the base soils that receive applications are also one of our largest natural resources. Thoughts of permanent damage or contamination to these vast markets should lead quality control planners to stand strong on high quality standards to ensure adequate land is indefinitely available for these applications.

HOMEOWNERS. As the general public becomes more educated about the benefits of using compost, its acceptance within this market segment will grow. Public interest in organic gardening and sustainable agriculture will also improve the marketability of composted products. Teaching the general public what is fact and what is fiction about compost, especially when it comes to health and safety issues, is of utmost importance.

Currently, the most popular composts being used by homeowners are leaf/yard waste and various animal manure composts. In specific areas, sludge compost has also been marketed to homeowners with great success, however, it has proven to be more difficult due to the natural stigma attached.

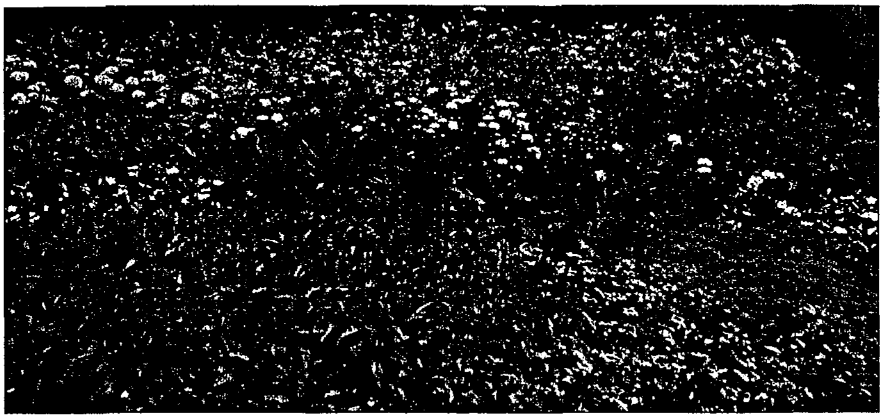
Municipal solid-waste compost will, no doubt, be more difficult to market to homeowners than other types of compost. This is because many MSW composts are not as aesthetically appealing as other types of compost. Most likely, only the MSW composts which are of the highest quality will gain wide acceptance with 'John and Jane Q. Public'. It has many of the same benefits as other composted materials possess and can be used in much the same way.

Composts which are marketed to homeowners must have a texture which makes them easy to work with and must have an attractive look. They must be consistent, free of weed seeds and objectionable odor. If the material is high in soluble salts or is unstable and causes a plant kill, homeowners will be turned off to the product for a long time.

Since homeowners do not have a technical background in the production or use of compost, the product we market to them must be of the highest quality. It is widely believed that the key to creating long-term markets for compost depends upon creating acceptance with the general public (homeowners).

As the popularity of compost application grows, it becomes increasingly more important that we understand how various composts are best used, as well as understand how specific end-users use the product and for what reasons. For this knowledge to grow, continued monies must be made available for appropriate research to develop new uses for our compost products.

As the production of composts increase, largely due to more scrutiny of our waste management practices, the need for knowledge and public support becomes a national and international issue, rather than a regional one. This fact makes it extremely important that as more research is completed and information obtained, that the data is shared throughout the industry in a way which will benefit all interested parties. Accomplishing this goal will benefit us in many ways from avoiding the duplication of research, to improving public relations.



Compost, when meeting the proper standards and applied correctly, can result in enhanced annual and perennial flower plantings.

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REFERENCES

Alexander, R.A.,"Sludge Compost: Can It Make Athletic Fields More Playable?" Lawn & Landscape Maintenance, July 1991, pp. 46-52.
Angle, J.S., D.C. Wolf and J.R. Hall III, "Turfgrass Growth Aided by Sludge Compost". Biocycle, Nov.-Dec. 1981, pp. 40-43.
Personal Interview with Francis Gouin, 21 May 1992.
Personal Interview with Bill Hendricks, Klyn Nurseries, Aug. 10, 1992.
Hoitink, H.J., Kuter, G.A., Effects of Compost in Growth Media on Soilborne Pathogens. The Role of Organic Matter in Modern Agriculture, ISBN 90-247-3360-x, 1986.
Kashmanian, R.M., Composting and Agricultural Coverage: Part I, State, Local and Agricultural Activities and Composting and Agricultural Coverage: Part II, Implications for Reducing Water Pollution for Livestock Operations and Erosion, publishing pending.
Personal Interview with Jay Kilbourn, Resource Conservation Services, Inc., 17 July 1992.
Logsdon, Gene, Plant Nurseries Cut Costs With Compost, BioCycle, May, 1991.
Lucas, R.E. and Vitosh, M.L., Soil Organic Matter Dynamics, Michigan State University Agricultural Experiment Station Research Report, Nov., 1978 32.91.
McCoy, E.L., Assessment and "Renovation of Residential Soils", Urban and Sports Turf Soil, 2nd Edition, 1990.
Nelson, Eric B., the Biological Control of Turfgrass Disease, Golf Course Management, April, 1992.
Personal Interview with Alfred Rattie, Compost Management, Inc., 17 July 1992.
Seattle Solid Waste Authority, Ceder Grove Compost Users Guide for Landscape Professionals, 1990.
Slivka, McClure, Buhr, Albrecht. Potential U.S. Applications for Compost Applications. Commissioned by the Proctor and Gamble Co. for the Solid Waste Composting Council, Jan., 1992.
Smith, E.M., and S.A. Treaster, Composted Municipal Sludge From Two Ohio Cities for Container Grown Woody Ornamentals, 1990.
Smith, E.M., and S.A. Treaster 1991.. Production of Annuals and Perennials Grown in Soil Amended and Mulched with Composted Landscape Waste.
Tietjen, C., and S.A. Hart, 1969. Compost for Agricultural Land Journal San. Eng. Division, Proc. American Society - Civil Eng. 15(SA2): 269-287.
Sopper, W.A., "Long-Term Effects of Reclamation of Deep Coal Mine Refuse Banks with Municipal Sewage Sludge," XII National Symposium on Mining, Sept. 22-27, 1991 (Lexington, Kentucky: University of Kentucky).
Tyler, R., Benefits of Using Compost in the Nursery, The Buckeye, January, 1991.

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