CORNELL WASTE MANAGEMENT INSTITUTE

Center for the Environment **Rice Hall • Ithaca, NY 14853 • (607) 255-1187**

MUNICIPAL SOLID WASTE COMPOSTING: ISSUES IN POLICY & REGULATION

Ellen Z. Harrison
Associate Director, Cornell Waste Management Institute
Tom L. Richard
Department of Agricultural and Biological Engineering, Cornell University

The management of municipal solid wastes (MSW) has become increasingly complex and expensive. Communities are moving towards integrated systems involving a number of management techniques to maximize the recovery of resources from the waste stream. **Organic materials comprise the majority of MSW** (typically 60-70%), so composting is likely to play a critical role in achieving the 40-60% waste reduction goals set by various states (Table 1).

Composting generally enjoys a favorable public response and there is broad agreement about the need to compost the organic fraction of the waste stream. However, when it comes to specifics, there is debate about the policies and regulations which should govern composting of solid wastes. In the United States, major revisions to federal rules regarding use of sewage sludges have recently been adopted (under section 503 of the Clean Water Act). These apply to any composts containing sludge, but **there are no federal laws or rules which specifically apply to solid waste composting**. A handful of states and Canadian provinces have adopted rules and many others are currently considering them. A number of European countries have established policies and standards and several have recently been revised to be more conservative.

Composting as a Component of Integrated Waste Management

Composting provides a means to recover the organic fraction of the waste stream to produce a usable product. Composting should be viewed as a manufacturing process, with a goal of making a product that is safe and that meets consumer needs. An integrated solid waste management strategy which includes source reduction and recycling can help to improve the quality of the finished compost products.

Source reduction includes reducing the amount and toxicity of the waste stream and therefore has positive implications for all other waste management options. Toxicity reduction is particularly important to the production of safe composts. Heavy metals, particularly lead and mercury, can be toxic and may restrict the use of composts. Thus reduction of the use of the metals in products which find their way into the waste stream will enhance composting.

Removal of recyclables will also enhance composting since glass, metals and plastics are undesirable in composts. Consideration of paper is more complex since some can be either recycled or composted. Composting of soiled and thus non-recyclable paper is recognized as appropriate,

MSW COMPOSTING FACT SHEET SERIES # 6

1. Physical Processing
2. Biological Processing
3. Strategies for Separating Contaminants
4. Potential Effects of Heavy Metals on Plants and the Environment
5. Issues in Risk Assessment & Management/Worker Health & Safety
6. **Issues in Policy and Regulation/Glossary**
7. Key Aspects of Compost Quality Assurance/Composting Resources

1993

Table 1. Composting and Recycling Potential of Municipal Solid Waste

• Total potentially compostable*	70% of MSW
• Total composted at 80% capture***	56% of MSW
• Total potentially recoverable**	85% of MSW
• Total recovered at 80% capture***	68% of MSW

* Total potentially compostable = newspaper, cardboard, other paper, food and yard wastes. Note: This calculation is based on what is potentially composted. It may be more desirable to recycle much of the paper and cardboard rather than compost it.

** Total potentially recoverable = total compostable (which includes some papers that may be recycled rather than composted) plus recyclable glass, metal and plastic packaging.

*** Total composted/recovered at 80% capture = total potentially compostable/recoverable x 80% because not all of this waste will be successfully diverted to recycling and composting due to imperfection of separation and collection.

but there is some debate about composting potentially recyclable papers. Most states consider composted wastes as "recycled" which is important in meeting state mandates for waste reduction.

There are essentially **two approaches to separating recyclables and compostables**. They can be source separated by the waste generator (homes and businesses) and collected and processed as separate streams, or they may be collected as part of a mixed waste stream which is then processed at some central facility to separate different components. There are a number of trade-offs between these approaches (Fact Sheet 3). Source separation is less convenient for generators and education is required to minimize contaminants in the source separated streams. If mixed wastes rather than source separated organics are collected and processed, a greater proportion of the organic fraction will end up in the composts because generators asked to source separate are likely to place some potentially compostable organics into the bin designated as non-compostable. On the other hand, a greater fraction of the heavy metal contaminants will also end up in composts made from centrally processed mixed wastes. Another fact sheet in this series describes the impacts of different collection and processing options on compost quality and concludes that source separation of compostables results in lower concentrations of metals in the composts. (Fact Sheet 3)

Whatever methods are employed, compost facilities will generate some **"rejects"** or non-compostables that must be disposed of at a landfill or incinerator. Policies must take into consideration the trade-offs between the desire to keep rejects to a minimum (in order to keep disposal costs lower) and the desire to minimize contaminants in the compost product.

Facility sizing is a critical issue in composting facilities and it will influence the economics of construction and operation and the amount of incoming waste that is needed to cover costs. The potential for managing appropriate commercial wastes (such as cafeteria or food manufacturing wastes) or for importing wastes from other communities should be considered. Too large a facility may discourage waste reduction or result in the need to "import" wastes while too small a plant will not provide capacity for all appropriate wastes and may not be economic to build and operate. There may also be the challenge of a highly variable quantity of compostable wastes due to seasonal changes in the waste stream or in community population in resort areas.

Compost Quality: How Clean is Clean Enough?

There are several options for regulating compost quality. A **"risk-based" approach** such as that used for regulating land application of sewage sludge is the most popular approach being used in most states. A risk analysis of the potential environmental and health impacts of the various chemical and pathogenic contaminants is performed and numerical limits are established for each contaminant which would be low enough to achieve a "no observed adverse effect level" (NOAEL). Under this approach, products meeting these standards could be applied without restrictions and without causing unacceptable risk to humans or the environment. Such a risk-based approach is predicated on having sufficient information to assess adequately the risks and establish thresholds below which risks are considered to be negligible or acceptable.

Based on extensive research, a comprehensive assessment for sewage sludges has been performed to develop Alternative Pollutant Limits (APLs) which meet NOAELs. Much less research and analysis are available on MSW composts and while there are many similarities between sewage sludges and MSW derived composts, there are also some important differences. The bioavailability of metals, ratio between different metals, and higher potential application rate for composts are among the most significant differences. One critical area where research is needed is the acceptable level of lead (Pb).

In contrast to this risk-based approach, other regulations in the U. S. in the area of water and air pollution control have sometimes followed a principal of **"best achievable technology"**. The regulations might specify process design and operation requirements. Submission of engineering documents relating to construction and operation are generally required for compost facilities and operational requirements are specified to control pathogenic organisms through elevated temperatures.

A third approach, requiring **"no net degradation"**, is currently being used to regulate composts in the Netherlands, Switzerland, selected German states and the Canadian provinces of British Columbia and Ontario. It is based on the philosophy that in order to insure the long term fertility of the soil, the levels of selected contaminants should not be increased over background soil levels. These are very stringent standards which in effect restrict composting to source separated clean organic wastes.

Even if policy makers agree on a particular approach, translating existing scientific information into regulation requires interpretation and is not cut and dried. Within the U. S., risk-based standards for such a key contaminant as lead vary by a factor of two, from 250 parts per million (ppm) for unrestricted use Class I compost in NYS to 500 ppm for Class I compost in Florida (Table 2, P. 4). The differences between risk based and no-net-degradation standards are even greater. For example the standard for mercury varies by a factor of 66.7 between NYS' risk-based standard (10 ppm) and Ontario's no-net-degradation-based standard (0.15 ppm) (Table 3).

Table 3. Comparison of Risk-Based and No Net Degradation Standards for Metals in Compost

	Risk-based (ppm)		No Net Degradation (ppm)	
	(Florida Class)	(NYS Class)	(Switzerland)	(Ontario)
Cd	15	10	3	3
Cr	-	1000	150	50
Cu	450	1000	150	60
Hg	-	10	3	0.15
Ni	50	200	100	60
Pb	500	250	150	150
Zn	900	2500	500	500

Compost Classification and Regulation of Use

Different **classes of composts** may be established which are based either on different maximum contaminant levels or on specified input feedstocks. Rules may restrict the use of the different classes of compost to different applications thus allowing a balancing of agronomic benefits against environmental risks. Thus composts meeting the most stringent standards may be allowed to be used without restriction while composts which meet less strict criteria may be restricted to use in non-food chain crops or to applications where people are unlikely to come into direct contact with the compost.

Current compost regulations are not sophisticated in their consideration of alternative uses for composts of different quality. Most classifications set up a single hierarchy of use and if a single parameter tests outside the standards for a class of composts, that compost is downgraded to the next tier of use. While this is a conservative approach, it may eliminate certain safe and appropriate uses. Ideally, restrictions should reflect the particular risk which the increased contaminant may pose. Thus with lead, for example, the risk analysis for sewage sludge indicates that direct ingestion by children is the most critical pathway. Therefore, composts not meeting the most stringent lead standard should be restricted to uses where children are unlikely to come in contact with the compost.

Cumulative Loading

Risk based maximum contaminant levels and sludge APLs are set at concentrations designed to protect plants, animals and people which might come into contact with that compost or sludge. While concentration limits address immediate or short term effects, repeated application over many years may pose additional long term risks as metal contaminants are concentrated in the soil. The new federal regulations for land application of sewage sludge consider the APL concentrations low enough that repeated applications would not cause undue risk. However, the use of sludges with metal levels above the APL concentrations but less than a maximum "ceiling" are restricted by **cumulative loading limits**. These limits set a maximum total amount of each regulated metal which can be applied to the land. For example, the APL for lead in sludge is 300 ppm and the cumulative load limit is 300 kilograms per hectare (kg/ha) (Table 2). If a sludge compost contained 500 ppm (above the 300 ppm APL rate but below the 840 ppm maximum ceiling) (see Table 2) and was applied at the rate of 20,000 kg/ha/year (or 9 tons/acre/yr), the cumulative limit would be reached after 30 annual applications (concentration * annual application rate ÷ cumulative loading = maximum site lifetime, e.g., 500 10^{-6}Pb 20,000kg/ha ÷ 300 kg Pb/ha = 30 years). In order to insure that application programs abide with these cumulative loading restrictions, the federal regulations require that each site using sludge containing metal concentrations above the APL limits receive a site specific permit.

Several European countries have set **restrictions on the rate and duration of compost application** even for composts meeting stringent "no net degradation" standards. Loading rates may be based on predicted contaminant losses from the soil through leaching or plant uptake, or they may be based on nutrient balance calculations. In either case, the goal of such restrictions is to protect the long term viability and vitality of the soil.

Facility Siting, Design and Operation

Compost regulations may also establish requirements for facility location and design in order to minimize potential impacts on neighbors from odors, traffic and potential environmental impacts on water quality. Among the requirements which may be included are set back distances from residences or water courses, availability of on-site utilities, minimum land area per ton of waste accepted, use of biofilters or other odor control systems and leachate collection.

Summary

Composting can play an important role in an integrated waste management system since a majority of MSW is comprised of organic materials. Source reduction and recycling can help to promote high quality composts by removing undesirable components from the waste stream prior to composting. Input materials to composting facilities can be limited to source separated "biowastes", which generally produce composts with the lowest levels of contaminants (Fact Sheet 3), or may be mixed solid waste which is processed centrally to remove non-compostable materials.

Production of high quality composts that meet consumer needs at a cost that is practical is key and these depend on both the collection system and the design and operation of the composting facility. The trade-offs between compost quality, the percentage of rejects that must be landfilled and total system costs require careful evaluation.

Several approaches have been used to set product quality regulations including risk-based standards, best achievable technologies and no-net-degradation of background soils. Combining these different underlying regulatory and scientific approaches with the political process of regulatory development results in a wide range of compost quality standards. In the United States, the various states which have addressed compost regulation have generally used a risk-based approach, while several Canadian provinces and European countries have adopted more stringent standards based on existing concentrations of metals in clean soils.

Where risk-based standards are used, maximum contaminant levels are established based on available research. The principle is that composts meeting these standards could be applied without restrictions and would not cause unacceptable risk to human or environmental health. Establishing product use restrictions for composts which do not meet the strictest standards, but which meet a less stringent classification, may provide for the beneficial use of these composts while protecting health and the environment.

Control of the site design and operating criteria of composting facilities through the regulatory process can help to protect the local community and water resources against environmental and nuisance impacts.

Municipal solid waste (MSW) composting is a rapidly evolving technology, and as such is subject to shifting policies and changing regulations. As with other policies and regulations, those related to MSW composting are influenced by a combination of science, economics and philosophy as mediated by the political process.

References

See the fully referenced article in a special issue of *Biomass & Bioenergy* (Vol. 3, Nos 3-4, pp.127-143, 1992), from which this fact sheet is extracted. A copy of that journal containing 11 articles on MSW composting can be obtained through the Composting Council, 114 S. Pitt St., Alexandria, VA 22314, for $30.

The research for this paper was supported in part by funds provided by Clark Engineers and Associates and the State of New York through the NYS Energy Office. Their support of this work is gratefully acknowledged. Thanks to Stephen Ebbs who carried out the massive literature search necessary to the preparation of this fact sheet. The authors are solely responsible for the papers' contents, although they gratefully acknowledge helpful comments and discussion with numerous colleagues.

Table 2. Summary of Contaminant Standards for MSW Composts

		PCB	Cd	Cr	Cu	Hg	Ni	Pb	Zn	As	Co	Mo
U. S. states												
Delaware		5	12.5		500	5	100	500	1250			
Florida	Class I		15		450		50	500	900			
	Class II		15-30		900		100	1000	1800			
Maine	Sludge but applies to compost	10	10	1000	1000	10	200	700	2000			
Massachusetts	Sludge but applies to compost											
	Type 1	1 or 2*	14	1000	1000	10	200	300	2500			10 or 25**
	Type 2	10	25	1000	1000	10	200	1000	2500			10 or 25**
Minnesota	Class I no sludge	1	10	1000	500	5	100	500	1000			
New Hampshire		1	10	1000	1000	10	200	500	2500			
New York	Class I	1	10	1000	1000	10	200	250	2500			
	Class II	10	25	1000	1000	10	200	1000	2500			
North Carolina	Code I	2	10	1000	800	10	200	250	1000			
	Code II	10	25	2000	1200	15	500	1000	2500			
Pennsylvania	Sludge	3	25	1000	1000	10	200	1000	2500			
U. S. sludge (503 rules; Nov. 92)	Alt. Pollutant Limits		39	1200	1500	17	420	300	2800	41		18
U. S. sludge (503 rules; Nov. 92)	Ceiling Limit		85	3000	4300	57	420	840	7500	75		75
U. S. sludge (503 rules; Nov. 92)	Cumulative Load (kg/ha)		30	3000	1500	17	420	300	2800	41		18
Washington proposed	Class A		2	200	60	0.5	50	150	270	15		
Other countries												
Austria			4	150	400	4	100	500	1000			
Belgium	Food Crops		5	150	100	5	50	600	1000			
	Non-food		5	200	500	5	100	1000	1500			
British Columbia			2.6	210	100	0.8	50	150	315	13	26	5
Italy			10	CrIII-500 CrIV-10	600	10	200	500	2500			
Netherlands	I (now)		2	200	300	2	50	200	900	25		
	II (by year 1995)		1	50	60	0.3	20	100	200	15		
	"very clean"		0.7	50	25	0.2	10	65	75	5		

Ontario	"clean" compost	1	3	50	60	0.15	60	150	500	10	25	2
	controlled compost	1	4	50	100	0.5	60	500	500	20	25	3
Spain			40	750	1750		400	1200	4000			
Swiss Compost			3	150	150	3	50	150	500			
Swiss Sludge			10	500	800	10	100	500	2000		60	20

Numbers are in ug/g = mg/kg = parts per million (ppm) dry weight except for sludge cumulative load which is in kilograms per hectare

PCB=polychlorinated biphenyls; Cd=cadmium; Cr=chromium; Cu=copper; Hg=mercury; Ni=nickel; Pb=lead; Zn=zinc; As=arsenic;

Co=cobalt; Mo=molybdenum
***1 for soil conditioner, 2 for fertilizer**
****10 for forage crops or on pasture, 25 otherwise**

Composting Glossary

(Extracted from a variety of sources or developed by the authors and presented for the convenience of the reader.)

AERATED STATIC PILE: composting system that uses a series of perforated pipes (or equivalent) as an air distribution system running underneath a compost pile and connected to a blower that either draws or blows air through the piles. Little or no pile turning is performed.

AERATION (for composting): bringing about contact of air and composting solid organic matter, by means of turning or ventilating to allow microbial aerobic metabolism (biooxidation).

AEROBIC: occurring in the presence of oxygen./ANAEROBIC: occurring in the absence of oxygen.

BATCH COMPOSTING: all material is processed at the same time, without introducing new feedstock once composting has begun; windrow systems may be batch systems.

BIODEGRADABILITY: the potential that an organic component can be converted into simpler compounds by metabolic processes.

BULKING AGENT: material, usually carbonaceous such as sawdust, wood chips, or shredded yard trimmings added to a compost system to maintain airflow by preventing settling and compaction of waste.

COMPOSTABLE: organic material that can be biologically decomposed under aerobic conditions.

CONTAMINANT: unwanted material; physical contaminants of compost can include glass, plastic and stones; chemical contaminants can include trace heavy metals and toxic organic compounds; biological contaminants can include pathogens.

CURING: the last stage of composting that occurs after much of the readily metabolized material has been decomposed. Provides for additional stabilization, reduction of pathogens, and allows further decomposition of cellulose and lignin.

DECOMPOSITION: the breakdown of organic matter by microbial action.

DEWATERED SEWAGE SLUDGE: municipal sewage sludge with a total solids content of 12% by weight or greater that can be transported and handled as a semi-solid material.

FOREIGN MATTER: non-biodegradable matter contained in MSW compost such as glass, plastic, metals, etc. They are permitted only at low levels in market compost. (Soil and sand are non-degradable but can be very desirable components in some market composts.)

HEAVY METALS; TRACE METALS: trace elements whose concentrations are regulated because of the potential for toxicity to humans, animals, or plants, and includes chromium copper, nickel, cadmium, lead, mercury, and zinc if present in excessive amounts.

HUMUS: a complex amorphous aggregate, formed during the microbial decomposition or alteration of plant and animal residues and products synthesized by soil organisms; principal constituents are derivatives of lignins, proteins and cellulose combined with inorganic soil constituents.

INERTS: non-biodegradable products contained in compost (glass, plastics, etc.).

INORGANIC: substance in which carbon-to-carbon bonds are absent; mineral matter.

LEACHATE: liquid which has percolated through, or condensed out of mixed municipal solid wastes and extracted dissolved and suspended materials; liquid that drains from the mix of fresh organic matter.

MATURE COMPOST (synonym of COMPOST): the stabilized and sanitized product of composting. It has undergone decomposition and is in the process of humification (stabilization); it is characterized as containing readily available forms of plant nutrients, poor in phytotoxic acids and phenols, and low in readily available carbon compounds.

MIXED WASTE PROCESSING: central facility for inspecting and sorting commingled waste materials generally for the purpose of recovering materials of value for recycling.

MOISTURE CONTENT: weight of water in material divided by weight of solids in material.

ORGANIC CONTAMINANTS: synthetic trace organics including pesticides and other synthetic chemicals.

PATHOGEN: an organism or microorganism, including viruses, bacteria, fungi and protozoa capable of producing an infection or disease in a susceptible host.

PHYTOTOXIN: toxins which may endanger plant viability or functionality.

SOURCE SEPARATION: the practice, by primary waste generators such as households and businesses, of separating waste generated within the household or commercial operation into separate fractions, such as all newspapers together, all glass together, etc. and of placing them in separate containers for pickup by the waste hauler.

STABILITY: the degree to which the composted material can be stored or used without giving rise to nuisances or can be applied to the soil without causing problems.

STATIC PILE SYSTEM: similar to aerated static pile except that the air source may be controlled or may not be controlled.

TOXIN: compounds that cause a reduction of viability or functionality in living organisms.

VOLATILIZATION: gaseous loss of a substance to the atmosphere.

WINDROW SYSTEM: composting mixture is placed in elongated piles, called windrows. These windrows are aerated naturally by a chimney effect, by mechanically turning the piles with a machine such as a front-end loader or specially designed equipment, and/or by forced aeration.

YARD TRIMMINGS: grass clippings, leaves and weeds, and shrub and tree prunings six inches or less in diameter, from residences and businesses.