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Guide to Agricultural Composting

Massachusetts Department of Agricultural Resources
Division of Agricultural Conservation and Technical Assistance

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MDAR
MASSACHUSETTS DEPARTMENT OF AGRICULTURAL RESOURCES

Revised 2023

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Introduction

These guidelines are primarily intended for Massachusetts farmers engaged in agricultural composting and, more specifically, for those who wish to compost materials not generated from their own farming operations. While the Commonwealth of Massachusetts recognizes and encourages on-farm composting, there are environmental considerations and state regulations that dictate circumstances when a farm may need either a permit or a compost registration.

Ultimately the composting process should lead to a usable, quality material that has value for land application. This guidance document describes the elements of composting that all operators should understand before undertaking the practice. Part I of the guidance discusses state regulations that pertain to composting, and the registration process. Part II describes the science of composting, which is a biological process and warrants a basic understanding. Part III describes compost recipe development. Part IV describes the predominant methods of composting. Parts V and VI identify planning considerations for site selection and design. Part VII describes operation and maintenance procedures necessary for successfully managing a compost operation. Part VIII describes the Process to Further Reduce Pathogens, or PFRP – an important element of the composting process which is both a best practice and may eliminate the need for an application interval prior to the harvest of food crops. Part IX outlines the information to include in preparing a Compost Plan for an Agricultural Composting Registration from the Massachusetts Department of Agricultural Resources ("MDAR"), and finally Part X describes Odor Management, and the preparation of an Odor Management Plan.

1 Regulations and Registration Process

Regulatory Background

The MDAR Agricultural Composting Program regulations, 330 CMR 25.00 define Composting as: "The process of accelerated biodegradation of Organic Materials using microorganisms under controlled conditions in the presence of oxygen using turned windrows or piles, aerated static piles, or in-vessel systems." Agricultural Composting is defined as "The Composting of Agricultural Materials and other Compostable Materials on an Agricultural Unit resulting in stabilized Compost suitable for agricultural and horticultural uses". Agricultural composting is a distinct sub-set of composting activity. Depending on the scale of the operation, siting, types and sources of materials being composted, composting may be viewed as an agricultural practice or as solid waste management. This is an important distinction as it determines which regulations apply and which regulatory agency has oversight.

The Department of Environmental Protection ("MassDEP") maintains primary regulatory authority over composting in Massachusetts, under 310 CMR 16.00, *Site Assignment for Solid Waste Facilities*. Farms wishing to engage in Agricultural Composting may utilize the following exemption within this regulation and may apply to MDAR to be registered as an Agricultural Composter:

310 CMR 16:03 (c) Handling or Disposal of Organic Materials.

1. Activities Located at an Agricultural Unit. Activities located at an agricultural unit as defined in 330 CMR 25.02: *Definitions*, provided that the owner and operator comply with the regulations and guidelines of the Department of Agricultural

Resources. If the Department of Agricultural Resources determines that the activity at a specific agricultural unit is no longer regulated by MDAR, then the owner and operator shall be subject to 310 CMR 16.00.

Role of the Department of Agricultural Resources

MDAR is responsible for administering an Agricultural Composting Program to register those operations that qualify for the "Activities Located at an Agricultural Unit" exemption referred to previously. The MDAR Agricultural Composting Program regulations, 330 CMR 25.00, may be found at www.mass.gov/agricultural-composting-program. An agricultural operation only needs to register with MDAR if it is planning to bring materials on to its property from off-site for the purpose of composting.

Composting using only feedstock generated onsite, does not require registration from MDAR and is not subject to 330 CMR 25.00.

In order for MDAR to register an operation as an agricultural composter, the operation must be located on an agricultural unit, as defined in regulation 330 CMR 25.02: A parcel of land for which the Department determines that: (a) the use is predominantly agriculture as defined in M.G.L. c. 128, § 1A; and (b) an agricultural product is sold as a normal course of business.

Under the MDAR Agricultural Composting Program, the registered farm may compost Agricultural or Organic Materials. **Agricultural Materials** are produced from the raising and processing of plants and animals as part of agronomic, horticultural, aquacultural, or silvicultural operations, including, but not limited to, animal manures, animal products and by-products (including carcasses), bedding materials, and plant materials. **Organic Materials** include any of the following source-separated materials: vegetative material, food material, agricultural material, biodegradable products, biodegradable paper, clean wood, or yard waste.

Organic Material does not include Sanitary Wastewater Treatment Facility Residuals, the land application of which is regulated by MassDEP.

Agricultural Composting Registration Process

Qualified farm operations wishing to obtain an Agricultural Composting Registration ("Registration") with MDAR must complete the "Agricultural Composting Registration Application Form," which can be found on the MDAR website (www.mass.gov/agricultural-composting-program) or obtained by calling the MDAR office.

When MDAR receives an Agricultural Composting Registration Application, it is reviewed for completeness, the farm is contacted, and a site visit is scheduled for MDAR staff to view the proposed composting location and discuss the operational plan. The following types of questions are considered when assessing suitability of the agricultural exemption:

- Is the composting operation located on an Agricultural Unit?[1]
- Is an agricultural product sold as a normal course of business?
- Are the materials described in the Compost Plan allowable under 310 CMR 16.00 and 330 CMR 25.00 to be composted?
- How integrated is the composting operation into the farming operation? MDAR Agricultural Composting Program regulations require a minimum of 25% inputs from the farm, OR 25% of finished product must be used on-farm for agricultural purposes.
- What are the characteristics of the neighborhood? Is the operation located in a rural or residential neighborhood? What is the proximity of the proposed compost operation to neighbors? What type of roads provide access to the farm? Is the site at least 100 feet from the property line? Based upon the materials and volume to be composted, is a 100 foot setback sufficient? Is the site hidden from neighbors by distance and screening?
- What is the composting knowledge base of the operator? Has the operator completed a basic course in composting? Does the operator have the time to devote to managing the operation?

Following the site visit, if a Registration is granted, a Certificate of Registration will be mailed to the applicant, which is valid for a period beginning with the actual date of issuance and ending on the following March 31st. At least 30 days prior to commencement, the owner or operator of newly registered Agricultural Composting Operations must submit a copy of their Registration to the local Board of Health and provide proof of submittal to the Department. Following this 30-day period, the Certificate of Registration allows the registrant to compost the materials specified, in the manner and location described in the application.

Each year the registrant will receive an Annual Report form and Renewal Application from MDAR to be filled out and returned prior to February 15th, in order to continue the registration for the next year (April 1-March 31). The registrant may be required to submit other information to MDAR, if requested. MDAR may charge a fee for a Registration and renewal, as permitted by law. Once the Registration is issued, the registrant must ensure that the agricultural composting operation remains in compliance with the regulations.

An agricultural composting operation must comply with the requirements set forth in 310 CMR 16.00 and 330 CMR 25.00. MDAR is authorized to suspend or revoke a Registration if the Applicant provides false, misleading, or inaccurate information regarding the Agricultural Composting Operation, or if the Registered Agricultural Composting Operation is in violation of the Registration, state or federal law, or the Agricultural Composting Guidelines. This suspension or revocation of the Registration will also revoke the exemption status and thereby the operation will be subject to MassDEP's Site Assignment for Solid Waste Facilities regulation, 310 CMR 16.00.

1 Agricultural Unit: A parcel of land for which the Department determines that (a) the use is predominantly agriculture as defined in M.G.L. c. 128, § 1A.

Application of compost to cropland using a spreader.

2 Basic Compost Science

Composting is a managed biological process which utilizes microorganisms naturally present in organic matter and soil to decompose organic material. These microorganisms require basic nutrients, oxygen, and water for decomposition to occur at an accelerated pace. The raw materials going into the compost are often referred to as "feedstock." The end-product, compost, is a dark brown, humus-like material which can be easily and safely handled, stored, and applied to land as a valuable soil amendment. The composting process is dependent upon several factors, including: the population of microorganisms, carbon to nitrogen ratio of the feedstock(s), oxygen level, temperature, moisture, surface area, pH, and time. These factors, which are described below, are dependent upon one another and understanding them is important for managing a successful compost operation.

Microorganisms

Microscopic organisms are responsible for decomposing organic materials, using it as food, and giving off carbon dioxide, water vapor, and heat in the process. They multiply rapidly and decompose most efficiently when they have food (i.e., compost feedstock) containing balanced nutrients, water, ample oxygen, and favorable temperatures. It is the composter's responsibility to maintain a proper balance of these conditions in order to promote microbial activity and hasten the decomposition process. More about Recipe Development can be found in **Part III.**

Nutrients – Carbon to Nitrogen Ratio (C:N Ratio)

The availability and proportion of nutrients, in particular carbon and nitrogen, can be a limiting factor in the composting process. Microorganisms require carbon for energy and nitrogen for protein synthesis in order to grow and multiply. The rate of decomposition is dependent on the balance of carbon to nitrogen in the feedstock. For rapid decomposition, the ideal carbon to nitrogen ratio is 30 to 1 (30:1). That ratio represents 30 parts carbon to 1 part nitrogen by weight. In general, a range of 20:1 to 40:1 is considered acceptable.

With a ratio of greater than 40:1, nitrogen becomes the limiting factor, and the rate of decomposition slows. Examples of materials with high C:N ratios are: dry leaves, sawdust, woodchips, and paper products. Carbon-rich materials tend to be dry and porous. These may be mixed with lower C:N materials to achieve an overall C:N ratio in the optimum range.

With a C:N ratio lower than 20:1, the excess nitrogen may be given off as ammonia or nitrous oxide. The resultant loss of nitrogen will lower the nutrient value of the end product. Examples of materials with low C:N ratios are poultry manure, fresh grass clippings, and food waste. Nitrogen-rich materials tend to be wet, dense, and are often odorous. Therefore, it is important to mix these with high C:N ratio materials to increase the carbon content for the microorganisms, and to absorb excess moisture and provide a bulking agent to achieve more pore space and oxygen in the pile.

Oxygen

The microorganisms that are primarily responsible for rapid decomposition are aerobic (oxygen-needing) organisms. If oxygen content falls below 5%, these aerobic organisms die off and are replaced by anaerobic organisms (which do not require oxygen). Anaerobic organisms operate less efficiently, resulting in a slower decomposition rate. In addition, the by-products of anaerobic digestion are methane, ammonia, and hydrogen sulfide, which can result in strong, unpleasant odors.

If sufficient oxygen is maintained during the compost process, odors can be kept to a minimum and rapid decomposition can be maintained. In turned windrow composting, turning the windrow or pile will introduce more oxygen into the mixture. Other methods of composting, such as static aerated or in-vessel systems use mechanical means of pumping air into a compost pile, assuring aerobic conditions are maintained during the process. Windrow size and bulk density of material also play an important role in pile aeration, as a large, heavy pile will not be able to 'breathe' as easily as a smaller pile.

Moisture

Microbial activity occurs in a film of moisture on the surface of the particles of organic material. The moisture is necessary to dissolve the nutrients utilized by microorganisms and to provide a suitable environment for population growth. Optimal moisture content for composting materials is 50-60% moisture, by weight. Too little moisture will inhibit microbial activity and slow down the composting process, while too much moisture will restrict the flow of oxygen because all pore space is taken up by water instead of air, and anaerobic conditions will begin to develop. If oxygen levels get too low, the compost pile will need to be turned.

Temperature

Heat is generated as microorganisms decompose organic material. Therefore, temperature is the best indicator of the rate of decomposition occurring in a compost pile. There are two ranges of temperature within which most of the composting process happens. Each range is based on the types of microorganisms most active at those temperatures. Both the mesophilic range (50-105°F) and the thermophilic range (over 105°F) support microorganisms that decompose organic materials, but the most active phase of composting – and most rapid decomposition – happens mainly in the thermophilic range. It is also in this range that pathogens and weed seeds are destroyed. Turned windrow composting requires the temperature of the compost to be 131°F or above for a minimum of 15 days (3 days for static aerated or in-vessel) during which the pile is turned five times in order to destroy human pathogens. Refer to the section on Process to Further Reduce Pathogens for more information about pathogen destruction. Most weed seeds are destroyed at 140°F.

As temperature exceeds 140°F, the rate of decomposition begins to decline as a less-efficient class of thermophilic organisms dominates. It is, therefore, recommended to maintain temperatures between 100-140°F for efficient composting during the active phase. When temperatures move out of the optimum range, it is usually because the level of oxygen has dropped too low or moisture level is no longer optimal (either too dry or too wet). Monitoring the temperatures in a composting pile provides a good guide as to when remedial measures may be needed to maintain or return to efficient composting conditions. Turning the compost piles greatly helps in moderating temperatures.

Surface Area/Particle Size

The activity of microorganisms during decomposition occurs on the surface area of organic material. With smaller particles, there is greater surface area per unit volume of material on which biological activity can occur. Also, nutrients are more readily available when the material is physically broken down. Thus, compost feedstocks with smaller particle size, such as shredded leaves, rather than un-shredded leaves, will decompose more quickly. It is important to keep in mind, however, that materials with very small particle size, such as sawdust, can become anaerobic due to compaction and restricted oxygen flow, so a mixture of particle size and texture is recommended for optimal composting.

pH

The composting process yields an end-product with a near neutral pH, regardless of the pH of the beginning feedstock materials. Normally it is not necessary to raise the pH by adding lime or ashes and, in fact, doing so may only raise the pH too high, which results in the formation and loss of ammonia. Certain feedstocks, such as cranberries naturally have a very low pH, and require a well thought out recipe and process to avoid problems during composting.

Time

Composting is an accelerated decomposition process; however, the length of time it takes to go from raw materials to stabilized, finished compost can vary considerably. Utilizing the windrow method of composting (properly managed), it is reasonable to produce finished compost within a one year period. If piles are turned infrequently, or the C:N ratio of the mixture is too high, then composting can take a year or more. Advanced composting systems, such as static aerated or in-vessel can significantly decrease the composting time.

There are two main phases to composting. The first phase is the most active phase of composting. This is where temperatures fluctuate between the thermophilic and mesophilic ranges and decomposition is rapid. A newly formed compost pile will quickly reach high temperatures and then as microbes use up the available oxygen, they will become less active and temperatures will drop. Introducing more oxygen into the pile by turning will cause the microbes to multiply rapidly again and the active phase will continue until oxygen is again depleted. This cycle will repeat – temperature drop, aeration, temperature rise – until all the easily digestible organic material is consumed by the microbes. When temperatures do not again rise after turning, then the compost is ready for the "curing" phase.

In the curing phase, different populations of microbes continue to decompose but at lower temperatures. This phase can last one to several months, during which time the compost becomes stabilized in the sense that by-products, such as ammonia, are no longer being generated in amounts that would be harmful to plants if compost were applied to the soil.

New compost pad prior to use.

3 Compost Recipe Development

Like baking a cake, a proper recipe is an important part of a controlled composting process. The object of a composting recipe is to provide the nutrients and conditions favorable for aerobic microbial growth and efficient decomposition of the organic materials you have chosen to combine for composting. Each feedstock contains nutrients and has other properties which determine both its suitability for composting and which materials might be combined with it to create a more favorable recipe for active, aerobic microbial growth. Knowing your materials is essential in developing a compost recipe. Plenty of 'book values' are available for most feedstocks, however laboratory testing can be helpful, and is sometimes necessary. Many factors contribute to a material's suitability for composting, however three of the most important are Carbon to Nitrogen Ratio, Moisture Content, and Bulk Density.

Carbon:Nitrogen

All organic materials contain carbon and nitrogen – in different ratios, referred to as the "C:N Ratio." Typically, materials which have a higher C:N ratio tend to be drier and lighter (leaves, sawdust, wood shavings, etc.), whereas those with a lower C:N ratio tend to be wetter, heavier, and often more odorous (manures, food scraps, fish waste, etc.). **An effective compost recipe will blend materials to achieve a C:N ratio of 30:1.** As a *general guideline*, this usually equates to three to five *parts* (by volume) of a carbon source mixed with one *part* of a nitrogen source. As an example, a recipe such as: one bucket cow manure (nitrogen source) mixed with one bucket of wood chips (carbon source) and three buckets of wood shavings (carbon source) could produce a favorable mixture for composting.

Moisture

All living things require water – and compost (and the microbes making it) is no different. However, just as humans can't breathe underwater, neither can aerobic microorganisms. A moisture level of 50-60% is ideal for composting. Bacteria and other microbes live on the moist film on the surface of composting particles. Too much moisture can displace the air in the pore space and cause the pile to become anaerobic – a slower, much more odorous process. Too little moisture can stall the process, or in some instances could contribute to conditions favorable for combustion – a VERY bad thing. One way moisture enters the pile is through the raw materials (which contain moisture), so it is important to combine wet feedstocks in your recipe with enough dry material to balance it.

Bulk Density

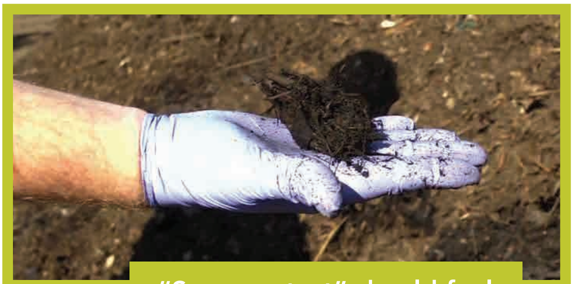
The weight of a volume of material is referred to as 'bulk density.' It is often measured in pounds of material per cubic yard. Excessive bulk density can be an impediment to the composting process by restricting the pile's ability to 'breathe.' Material which is too heavy (dense) will compact, reducing the pore space in the material, and the pile is likely to become anaerobic much more quickly. Bulk density can sometimes dictate how large a pile can be, as larger piles with high bulk densities don't allow airflow, so recipes with higher bulk densities likely will require piles to be smaller.

Generally, recipes start with materials on hand. For example, dairies, horse farms and chicken farms typically have quantities of manure on-site. Sometimes manure (and bedding material) will compost quite nicely without further inputs. However, sometimes the moisture, nitrogen, or bulk density (weight) will be less than favorable and require the addition of complimentary material. As noted above, the goal is to create favorable conditions for microbial growth, so if the manure is too dense or wet, a complimentary feedstock material will be one which distributes the moisture and reduces the density – in this instance, materials with a higher carbon content such as shavings or leaves mixed into the manure can accomplish those goals.

Materials with high nitrogen and high moisture are often odorous when they arrive – if not when they arrive, then soon afterward. Such materials require immediate incorporation using an **appropriate recipe** – one which balances:

- The high moisture of the wet material with a dry high carbon material, such as leaves or shavings, to arrive at 50-60% moisture.

- The high nitrogen level of the wet material with the high carbon level of the dry material to arrive at 30:1 C:N.
- The high bulk density (weight) of the wet material with lower bulk density of the dry material to arrive at a bulk density of 800-1000 lbs./cubic yard.



"Squeeze test" should feel like a wrung-out sponge.

Usually, this is not as complicated as it may seem. Many times, the recipe can be estimated by combining 3-5 parts of a carbon source (leaves, shavings, etc.) with one part of the nitrogen source (manure, e.g.).

Moisture content of a mixture can be estimated using a simple squeeze test: In a gloved hand, take a palmful of the material and squeeze it. The material should have the feel of a 'wrung-out' sponge. Liquid should not drip from your fist, but you should notice just a bit of 'glistening' between your fingers. If there is too much moisture, additional volumes of dry, high carbon material are likely required to balance the recipe.

Bucket test can help determine bulk density.

A simple 'bucket test' can provide an estimation of a material or recipe's bulk density, and facilitate compost recipe modification. The test is conducted with a 5-gallon bucket and a bathroom scale:

1. Place the bucket on the scale and tare the weight of the bucket (zero-out the scale).
2. With a shovel, fill the bucket 1/3 full, and then drop the bucket 10X to settle the material.
3. Fill the bucket to the 2/3 full level, and again drop the bucket 10X to settle.
4. Fill the bucket to the top, and again drop the bucket to settle the material.
5. Fill the bucket to level top.
6. Place the bucket on the scale, and the weight should be 20-25 lbs. This equates to 800-1000 lbs./cubic yard.
7. If the material is too heavy or too light, adjust the compost recipe accordingly.

4 Composting Methods

There are four basic composting methods, three of which will be discussed here. The fourth, passive composting, is an unmanaged composting method that is difficult to do without producing odors, requires very long composting times, and is not recommended by MDAR in most circumstances.

Turned Windrow Composting

Turned windrow composting is the method used most often for on-farm composting. Compost is formed into long, narrow piles. The size of windrows is an important factor in composting effectiveness and should be determined by the nature of the materials being composted, equipment used for turning, and the pile temperature and moisture conditions. In most cases, freshly stacked windrows should be no higher than 7 feet at formation, so they settle to about 6 feet. Often, even smaller windrows are appropriate, based upon pile conditions. This practice will keep piles more aerobic and promote temperatures in the optimum range of 120-140 F. If a windrow is too large or the material is too dense, the windrow won't breathe adequately, creating anaerobic conditions, and resulting in slow composting, and odorous conditions. Windrow lengths are usually based on area site constraints, or the logical volume of throughput needed to maintain batches with materials of like age.

Compost Windrow Turners

Shape of windrows is another important factor in the composting process. A properly constructed windrow will "breathe in" air from the base, and "breathe out" through the center/top of the pile. Piles that are too tall and wide tend to overheat and can go anaerobic in their core. Properly sized, triangular shaped windrows will facilitate aerobic composting, as well as help to shed water during rain events, reducing the chances for anaerobic conditions to develop.

If windrow temperatures are routinely too high, it could be a sign that the pile is too large, as larger piles will retain heat through insulation. Reducing windrow size could be a remedy for this condition. In colder months, windrows may need to be slightly larger to retain heat and maintain active composting conditions. Additionally, older compost – which requires less oxygen and generates less energy – can be consolidated into slightly higher piles as it matures. It's also important to keep in mind that larger piles retain moisture, which may be either beneficial or detrimental, depending upon existing moisture conditions in the material.

Windrow turning frequency is determined based upon pile monitoring, process observation, and weather conditions. As decomposition progresses, the pile volume will shrink by 25% to 75% of the original size depending on the density of the original mix. Two or more windrows may then be combined to make room for new raw materials.

Static Aerated Piles

A base layer of porous material such as coarse woodchips (called a 'plenum'), is formed around lengths of perforated pipe. Raw materials to be composted are thoroughly mixed and then formed into piles atop the base layer. The pile may

Static Aerated Bin Composting System

be topped with a geotextile cover or with a layer of finished compost to help retain odors, heat, and moisture. The piles are not turned, but rather aerated by mechanical blowers that force air into (or suck air through) the piles via the pipes.

In-Vessel Composting

This method utilizes a variety of aeration techniques, all of which involve containment of the compost. The initial composting process time can be quite short – as little as several weeks, which can be helpful in containing odors during this phase, however the material is still biologically active, and must be managed until finished curing. Up-front costs for these types of units (purchase and set-up) can be high, but they can be very effective under the right circumstances.

Rotary drum style in-vessel compost system.

5 Site Selection

Proper site selection is prerequisite to the establishment of safe and effective composting operations. The location of a composting operation directly impacts the amount of site preparation required and the measures needed to satisfy environmental and regulatory requirements.

Protection of Water Resources

Sites need to be evaluated for their potential impact on water resources. Of primary concern are proximity to water supplies, wetlands, floodplains, surface waters, and depth to groundwater.

1. Sites must not be located within 250 feet of a private well.
2. Operations must be sited in accordance with the Massachusetts Wetlands Protection Act. Under the wetlands regulations, siting of composting and storage areas is considered "normal improvement of land in agricultural use" when it occurs on land in agricultural use, when it is **directly related to the production or raising of certain agricultural commodities**, and when it is undertaken in such a manner as to prevent erosion and siltation of adjacent water bodies and wetlands.
3. Sites should be located at such a distance to ensure that there will not be any potential adverse impacts from compost site runoff into surface waters.

4. Sites which will be composting more than a minimal amount of material should construct a gently sloped composting pad, or area with an improved surface (crushed concrete, gravel, driveway base, etc.), to reduce rutting from repeated use of equipment and allow for proper maintenance of the composting piles.

5. A diversion berm on the up-slope side of the composting site is recommended to reduce the flow of 'clean' water running onto the compost pad, and a filter on the down-slope side, such as a small berm of wood chips, or a grassy strip, is recommended to reduce runoff of nutrients or sediment leaving the pad during rain events. A retention basin may also be used down-slope to capture nutrient rich water.

6. Sites should be avoided where groundwater rises closer than 4 feet or where bedrock is closer than 5 feet from the surface. Such conditions may lead to an operating surface that is too wet, and it increases the potential for nutrients to leach into groundwater.

Buffer to Sensitive Land Uses

With the recent rate of Massachusetts land development, many farmers are encountering new neighbors who like the idea of living next to a farm, but not the odors and noises of a farm. In these situations, the close proximity of residences, schools, or parks, may actually warrant the use of composting instead of the alternative practices of spreading or stockpiling raw manures. However, management of a composting site becomes **especially critical** when sensitive land uses are nearby.

Buffers, in the way of distance and/or visual screens, can go a long way toward reducing the real or perceived aggravations of noise, odor, litter, and aesthetic objections often associated with composting operations. A distance of at least 300 feet from the nearest residence to the composting area is recommended, and the **composting site must be at least 100 feet from the property line**. Most importantly the buffer must be adequate to satisfy reasonable neighbor concerns. Keep the activities as far away from the property line as possible.

Area Requirements

Sites must be of adequate size to handle the projected volume of material to be composted. MDAR regulations require that the composting area is tied to the size of the farm, and be no larger than 10% of the farm's Commercial Production Area, with a maximum composting area (regardless of the size of the farm) of 10 acres. A maximum of 5,000 cubic yards of composting material are allowed *per* *acre of compost site*, and the total volume of composting material (including raw material, in-process, and finished compost) is 15,000 cubic yards. So, if a farm wishes to compost 10,000 cubic yards of material, the compost area would need to be at least 2 acres, and the commercial production area of the farm would need to be at least 20 acres.

In addition to the actual footprint of the compost piles or windrows, consideration must be made for the area required for drop-off and mixing of materials, equipment maneuvering, curing areas, storage of finished compost, and buffer areas between the compost site and sensitive land uses. The area used for these activities is included in calculating the allowable size of a composting area of an MDAR registered farm.

The main point is that an operation should not have an unmanageable volume of material on site. In general, the less-intensively compost piles are managed, the more space is required because composting times will be longer. If piles are turned frequently or if air is pumped into static piles via perforated pipes, then composting times will be reduced and a smaller area will be required for a given volume of material.

Topography

Site preparation can be a significant startup cost for composting operations. Sites which will be composting more than a minimal amount of material should construct a gently sloped composting pad, or area with an improved surface (crushed concrete, gravel, driveway base, concrete, asphalt, etc.), to reduce rutting from repeated use of equipment and allow for proper maintenance of the composting piles. Sites that are open, nearly level, and needing minimal surface preparation are preferable. A gentle slope (1-3%) is optimal to allow water to run off and prevent ponding. Composting on steep slopes may impede the maneuverability of equipment and can cause runoff and erosion problems. These sites should be avoided when possible.

Accessibility

Compost operations should be readily accessible to all vehicles and equipment normally expected on the site. Sites must be secure from indiscriminate access that might lead to potential vandalism or dumping of unwanted material. If the primary means of entry onto the farm is near many residences or other sensitive land uses, consider alternate, more remote entrances for trucks associated with the compost operation, if possible.

6 Site Design

Once selected, the compost site must be designed to promote efficient operation and to minimize adverse environmental impacts. Design requirements will vary with the method of composting, type of equipment employed, and the physical characteristics of the site. Farmers should consider the following issues when planning for composting significant volumes of materials.

Surface Preparation

The most common method of on-farm composting involves forming windrows that are turned with a front-end loader. This requires a surface capable of handling frequent, heavy equipment which can stand up to the scraping action of the bucket and prevent rutting caused by tires.

Often it is advisable to construct a compost pad, or a hard surface upon which composting occurs, using materials (such as driveway base, crushed concrete, compacted gravel or an impermeable surface of asphalt or concrete) suitable for repeated use of heavy equipment. Areas which are subjected to the most use (such as drop-off/mixing area, and the active phase of windrow composting) should be the focus of efforts when designing and constructing compost pads. A properly constructed and maintained compost pad will help prevent ruts or ponding, and will help separate the composting organic material from the substrate (compost pad).

If rutting occurs, the pad should be graded to eliminate ponding. Standing water at the base of windrows can lead to anaerobic conditions in the pile and result in inefficient composting and odors. Ponding due to rutting caused by equipment should be avoided at all costs. The design and construction of a drop-off and mixing area for compost feedstocks on the compost pad is an important part of an operation. As these areas are heavily used – often by heavy equipment – extra attention should be given to the type of material used in surface preparation. This area is one of the most likely parts of the site to require maintenance and it is important to keep it in good repair.

Drainage and Runoff Management

Compost windrows should be oriented up and down the slope rather than across the slope so that rainwater can flow between the rows. The runoff that leaves the compost area must be managed to prevent erosion downslope, and runoff should not enter surface waters. A simple way to slow down runoff and remove contaminants is to use a combination of a berm of coarse woodchips and a level, wide, grassy area below the windrows. The berm will capture/filter runoff from the compost pad, and the grassy area will both filter and utilize nutrients in runoff water. More elaborate systems comprised of diversion ditches and detention basins may be warranted if topography and layout do not allow for a simple vegetative treatment area.

Additionally, reduction of water coming onto the compost area from upslope is an important factor to consider. Water should be diverted around the site to keep the compost area as dry as possible. Berms and diversion ditches can be constructed to keep uphill water from flowing onto the compost site.

Roads

Access roads should be designed to make drop-off and pick-up of material as easy as possible. They should be designed for a circular traffic pattern where feasible. Roads should be capable of supporting delivery and fire vehicles during all four seasons, and designed to minimize erosion and dust.

Visual Screens

Visual screens should be considered for farms located in more populated settings. Protecting the aesthetic integrity of the neighborhood will go a long way in reducing opposition to composting operations. There are many options for blocking visibility from neighbors and public roads, such as planting or leaving in place a dense thicket of trees or tall hedges, constructing a high earthen berm, building a fence, or strategically placing outbuildings and other farm structures.

Access Control

Controlling access to the site prevents illegal dumping and vandalism. The level of security required is dependent upon the potential risk for illegal behavior. Gates, fences, or cables at access points would prevent easy entry. Natural barriers are also good inhibitors.

Signs

While most farm-based compost operations will not need signs, those operations that are highly visible or that encourage drop-off by individuals may benefit from appropriate signage. A sign could be posted at each entrance indicating the operation name, nature, and operator. On-site signs would be helpful in directing vehicles to unloading and pick-up areas, identifying traffic patterns and prohibited areas.

On-Site Water Supply

Operations may need to have a water supply for wetting the piles if they become too dry, and for fire protection in the case of larger compost sites. Possible sources include ponds, streams, wells, public water supply, or water trucks. Water requirements may sometimes be determined partly based on the moisture content of the incoming feedstocks in addition to weather conditions during composting.

Well formed windrow with pad in good repair.

7 Operation and Maintenance

Even well-designed operations, located on well-chosen sites will prove problematic if not properly operated and maintained. Composting involves "managed" decomposition, so it is crucial to closely monitor every aspect of the compost operation to avoid unexpected and unwanted results, which can quickly lead to strained relations with neighbors and local officials, environmental violations, and an undesirable end-product. The following sections briefly describe key areas of management to help ensure a successful compost operation.

Quality Control of Incoming Materials

The types and quantities of off-farm materials to be accepted at the operation should be clearly stated – ideally in writing – to haulers. This practice will help settle disputes later if unwanted material (contaminants) should be found in a delivery or if the volume of material dropped off is more than can be effectively handled. However, despite making these conditions explicit to the suppliers of feedstock materials, every delivery to the farm should be inspected for quality. Unfortunately, a small amount of physical contaminants can be expected, such as pieces of plastic in yard waste deliveries, and they should be removed as much as possible *before* materials are mixed and composted.

Equipment and Staffing

The equipment required for composting depends on the composting method used and the volume of material to be processed. A front-end loader such as a farm tractor, skid steer, articulating loader, etc., is the most basic piece of equipment that is required. Other equipment might be necessary for the following activities: delivery and transport to and from the site; mixing materials; turning/aerating piles; monitoring temperature; watering; screening; grinding; bagging; spreading finished compost. As with any farming operation, it is imperative that all equipment be maintained in good working condition.

Staffing needs will depend on the type of equipment used and the volume and type of material processed. It is desirable to have an operator on-site to log and inspect deliveries of incoming materials, and it becomes critical when incoming materials are likely to become odorous and require immediate mixing with high carbon material. Composting can involve a substantial time commitment on the part of site operators, so the number of staff and hours involved should be well understood from the outset. Plan for known busy periods on the farm (e.g., planting and harvesting times) either by having more staff on hand for the composting operation, or consider limiting the quantities of incoming materials during such times. Do not accept more material than your equipment, staff, or facility can handle.

Storage of Material Before and After Composting

Materials can be delivered to staging areas for storing and mixing, or directly to the area of pile formation. While delivery straight to the piles saves time and cost, staging areas speed up the delivery process, allow for more thorough mixing, and lead to better pile formation. Delivered materials should be incorporated into composting piles before anaerobic conditions and resulting odors develop. Farms should make sure they have an adequate supply of high carbon material onsite, prior to the delivery of any high nitrogen materials, which must be mixed immediately upon delivery.

When the active, high heat phase of composting is finished, the pile can be moved to an area for the curing phase. Because odors are not a problem at this point and the pile will not need aeration, piles can be larger. When the curing phase is finished and the compost is ready to be used or sold, it may be moved to yet another location to accommodate easier pick-up or transport of material. The site should be designed such that the raw materials and active compost windrows are on the down-slope (lower) side of the pad, and as the compost nears the curing phase, it is moved up-slope of the newer material. This helps to assure that water runoff from an unprocessed pile does not run through finished (processed) compost.

All staging, mixing, and storage areas should be kept neat and orderly.

Too Hot!

Just Right!

Monitoring and Managing Compost Piles

All the necessary conditions for microbial activity must be monitored and managed within the compost piles. Windrow temperature can be monitored with a dial thermometer that has a stem long enough (36 inches) to reach the interior of the pile. Measurements should be taken at several locations to get a more accurate reading for the pile (or section of windrow) in question. When the temperature gets too high (>160°F) the pile should be turned to release heat. Likewise, when the temperature drops below 100°F prior to stabilization, the pile should be turned to introduce more oxygen for the microbes. A pile which continues to produce heat >160°F may be too large (retaining heat through insulation) or may need a modified recipe.

As described in Part III, moisture can be monitored by using the "squeeze" test. A handful of compost should ball up and feel moist when squeezed, but not to the point of dripping water. If the pile gets too dry, water can be added using a hose or sprinkler during turning, or the pile can be turned while it is raining. Another strategy for adding moisture to a windrow can be to flatten the top prior to a rain event, and then mixing and re-forming the windrow shape after the rain stops. Simply sprinkling water on top is usually not sufficient because water tends to shed off the windrow. If the pile is too wet, it can be turned on a dry day, remixed with drier materials, and/or formed into smaller windrows.

Record Keeping

Record keeping is an often overlooked, yet essential component of composting – it is also a regulatory requirement of all MDAR registered composters. A logbook should be kept for incoming materials, recording date of delivery, type of material, volume and/or weight, and source. Records should document the mix or "recipe" of raw materials that are used to form compost piles so that adjustments can be made and an optimum recipe achieved. These records should also indicate dates of pile formation, temperature readings, turning dates, amount/date of water added, date it was combined with another windrow and the date it was moved to the curing pile. Notes should be added where needed.

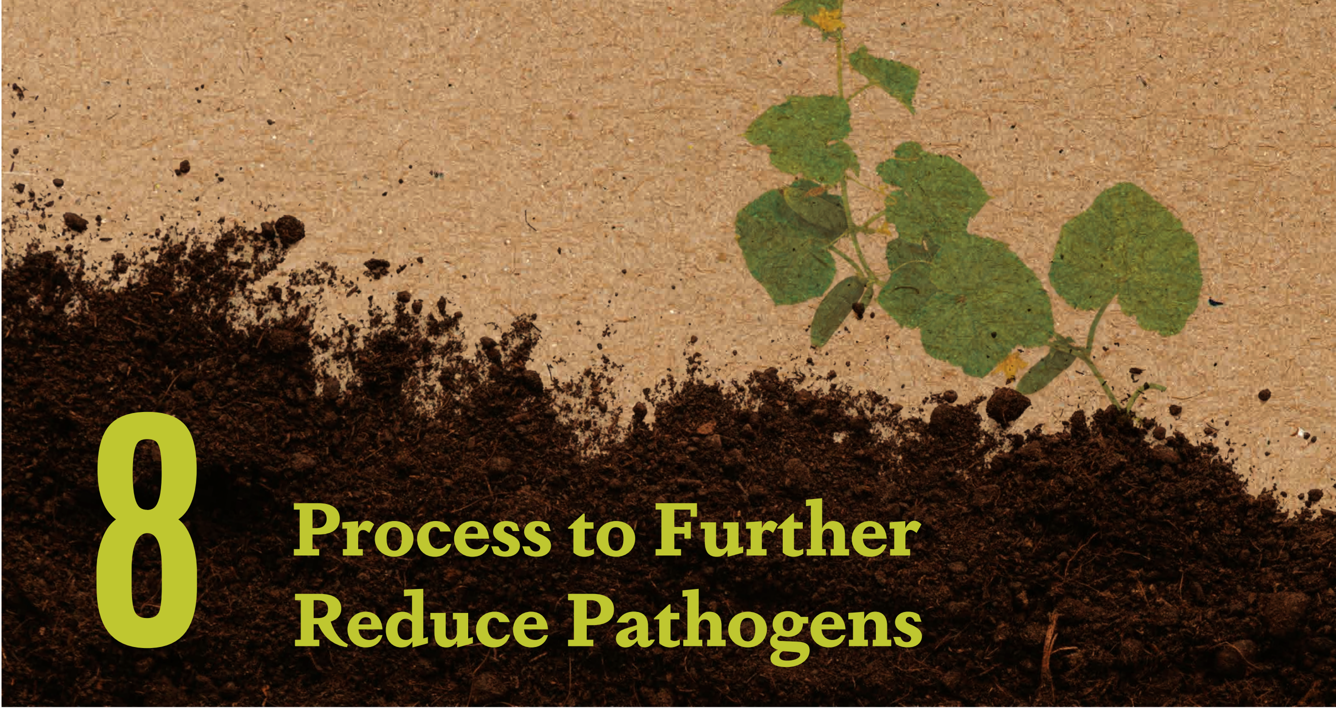
When windrows are formed over a period of time, flags or stakes can be set into the windrow to differentiate a younger section from an older one. These records will help the compost operator understand the throughput potential of the operation.

A wind indicator to show which way the wind is blowing is important. Wind speed and direction should be recorded daily and should guide the operator when (not) to turn piles, based on proximity to neighbors.

For a sample Windrow/Pile Temperature Monitoring record-keeping form, see Appendix A . MDAR Registered Composters are required to maintain accurate records of Compost management for at least three years to demonstrate compliance with 330 CMR 25.00 . The Department reserves the right to request and review such records at any time.

Contingency Plans

A contingency plan is important because it will allow for an alternative management plan in the event of contaminated deliveries, natural disasters, fiscal problems, and equipment failures. An acceptable backup site should be identified where material can be moved, if necessary. If finished compost is not selling or otherwise not being used and storage space is at capacity, **new incoming materials should not be accepted.** If a contaminated delivery is made, the supplier should be contacted, and required to take the load back.



8 Process to Further Reduce Pathogens

One of the factors which must be considered when producing and using compost for agricultural purposes is food safety. As composting is accomplished largely by microorganisms, precaution needs to be used to safeguard against pathogens. Under the Food Safety Modernization Act, the US Food and Drug Administration (FDA) established farm food safety standards, including the application of soil amendments (including compost) to food crops.

FDA and USDA's National Organic Program (NOP) regulations do not require an interval between manure application and food crop harvest if the manure is treated by a composting process that is consistent with NOP composting standards.

For composting manure and other feedstocks of animal origin such as food scraps containing meat, FDA (21 CFR 112.54) approves of two scientifically valid controlled composting processes, or Process to Further Reduce Pathogens – 'PFRP':

- Static composting that maintains aerobic (i.e., oxygenated) conditions at a minimum of 131°F (55°C) for three consecutive days, and is followed by adequate curing; and
- Turned composting that maintains aerobic conditions at a minimum of 131°F (55°C) for 15 days (which do not have to be consecutive), with a minimum of five turnings, and is followed by adequate curing.

Following the curing period, it is crucial that the finished compost NOT be mixed or come into contact with material which has not undergone the PFRP, as it would no longer meet the FDA/NOP standard. Documentation that the standard has been met is likely to be required by farms who would purchase your compost to improve their soil.

All MDAR registered composters are strongly encouraged to develop their operations so their composting process meets the PFRP standard.

Turning windrows with front-end loader.

9 Preparing a Compost Facility Plan

A well-developed plan facilitates the compost registration approval process. The composter should ensure that each component of the operation – from securing feedstock materials to end-use of the finished product – has been fully thought through and planned out. In most cases, the plan should not require engineering designs or detailed scientific descriptions of the composting process. However, it should include written descriptions, maps and sketches in order to convey the physical location and layout of the site, the operation and management plan, and plans for the final product. The following provides more details on what should be included.

Compost Facility Plan including each of the following elements:

Description of the intended method of Composting.

Composting Site location information.

Description of each type of Feedstock to be Composted, including source, volume, frequency of delivery, etc.

Volumetric Recipe for converting the Feedstock into Compost,
e.g.: 1 part horse bedding : 2 parts leaves : 1 part chicken manure.

Compost End-use Information: (applied to fields, sold, etc.), include estimated volume and percentage of the total quantity of Compost produced to be used on the Agricultural Unit.

Distance to Sensitive Land Uses: Describe the presence of close neighbors, schools, playing fields, etc. Indicate distances to each.

Drainage and Runoff Management: Describe how runoff will be controlled at the site. Indicate any berms, diversion ditches, detention basins, or vegetated treatment areas on an attached map or sketch.

Staging Procedures: Describe delivery and drop-off of raw materials, including location, mixing methods, etc.

Quality Control: How will the quality of the feedstock material and of the finished compost be monitored? How will non-compostable materials (e.g., plastic) be removed and disposed of?

Mixing and Piling Materials: How will the compost piles/windrows be mixed and constructed? Provide the number, height, length, and width of the piles.

Aeration: Describe the method and type of equipment that will be used for aerating the compost piles.

Composting Time Duration: Estimate how long composting will take from beginning to finished product.

Personnel: What personnel will be used and how will they be trained?

Equipment: What equipment will be used and for what purposes?

Contingency Plan: Is there an alternative, temporary site to which the compost can be moved should the primary site become unusable?

Odor Management Plan: Required for registration – refer to Section X.

Maps

Two Maps are required to be included within the application for MDAR Registration. Google Earth or equivalent style maps to scale are acceptable:

Location Map ("zoomed out") showing the compost site in relation to roads, town boundaries, and natural features such as streams and water bodies, wetlands.

Site Plan Map ("zoomed in") showing the layout of the Agricultural Composting Operation, including the following elements:

- **a.** Property boundary showing setback distance.
- **b.** Location and orientation of windrows. Draw the number of anticipated windrows onto the plan, indicating length, width, and spacing between windrows.
- **c.** Location of drop-off, mixing, and loading areas.
- **d.** Location of curing and/or storage areas.
- **e.** Location of farm roads, public roads.
- **f.** Drainage and runoff controls (e.g., berms, swales, grassed areas). Indicate direction of water flow.
- **g.** Surrounding farm buildings and fields.
- **h.** Surface water and wetlands including setback distance.
- **i.** Drinking water wells including setback distance.
- **j.** Occupied buildings within 300 feet of the compost site.
- **k.** High fences, tree lines, hedgerows, or other visual screens between compost site and the public.

10 Preparing an Odor Management Plan

Odors are the number one cause of composting operation complaints. For this reason, and to ensure sound composting practices, MDAR regulation requires that all registered agricultural composters have (and implement when necessary) an Odor Management Plan.

Odor Management Plan: A plan that is appropriate for the size and type of the operation that will minimize the production and migration of odorous compounds. The plan should at a minimum address the following:

a. Evaluation procedures, including odor strength, duration, and frequency.

b. Diagnosis of source of odor.

c. Outline remedial actions that may be utilized to address production and migration of any odors, including specific actions such as operational changes that will be taken to address complaints if odors occur beyond the property line of the Agricultural Unit.

MDAR regulation also requires:

a. The Applicant shall ensure that there is a written Odor Management Plan in place. The plan shall be kept at the premises of the Agricultural Composting Operation and available for inspection by the Department upon request.

b. Upon the Applicant noticing an odor, or upon receipt of a complaint about an odor beyond the property line of the Agricultural Unit from abutters or the Department, the Applicant shall implement the Odor Management Plan.

In some composting circumstances, odor is unavoidable – however, it IS manageable. Odor management should be viewed by the operator holistically, as part of understanding the composting process, and identifying issues through monitoring, so remedies can be applied *before* they become problems.

Odors associated with composting can be the result of a variety of causes, however, persistent odor is often the result of poor management practices. Being familiar with sound composting principles, monitoring regularly, and having proper equipment and feedstock on-hand is essential to avoiding problematic odors on compost sites. Understanding the cause of the odor will allow the operator to make corrections and bring the pile back into 'balance' or take other actions to reduce the likelihood of neighborhood disruption.

Your site could be "odor-free" for 100 days, but if an odor problem occurs, it is the odor which will be remembered. Fortunately, with some knowledge, equipment, materials, and regular monitoring, many operational issues which cause odor can be identified and remedied before they become problems.

The cause of composting odor often falls into one (or a combination) of several categories:

1. **Odors from the raw materials (feedstocks) themselves:** Materials with high nitrogen and high moisture are often odorous when they arrive – if not when they arrive, then soon afterward. Such materials require immediate incorporation into an **appropriate recipe** – one which balances:
    a. The high moisture of the wet material with dry material from a high carbon source, such as leaves or shavings, to arrive at 50-60% moisture.
    b. The high nitrogen level of the wet material with the high carbon level of the dry material to arrive at 30:1 C:N ratio.
    c. The high bulk density (weight) of the wet material with lower bulk density of the dry material to arrive at a bulk density of 800-1000 lbs/cubic yard.
2. **Odors from Anaerobic Pile Conditions:** Anaerobic decomposition of organic material is often a very odorous process, resulting in the emission of numerous potent greenhouse gases such as methane and nitrous oxide. The objective of composting is to create conditions favorable for *aerobic* bacterial growth. Windrow composting accomplishes this through pile shape and size: an elongated pyramid shape allows air to enter the pile from the foot and sides of the pile, and 'exhale' through the top. The windrow should be small enough for air distribution into the pile, but large enough to retain heat though insulation. A pile which is too large will retain too much heat, and likely be too heavy to function well. Once the oxygen is used up in a pile, anaerobic bacteria become more active, and odors usually arise.

Another very important parameter to be measured in composting is pile temperature. This is an indicator of microbial metabolic activity and is typically measured using a thermometer with a three-foot long stem. Once a pile reaches temperatures above 140°F, favorable composting bacteria die or become inactive, and anaerobic bacteria take over, slowing down the process, and usually contributing to odors.

A common method of temperature monitoring which gives an indication of pile activity is to monitor the windrow temperature at both the three-foot and one-foot depths. As a rule of thumb, a temperature difference of greater than 20°F between three feet and one foot in an active pile (for example, a three-foot reading of 110°F, and at the one-foot depth, a reading of 140°F), could indicate that the middle of the pile wants to breathe, but isn't getting enough air. It is likely time to turn the pile at this point.

A prudent management strategy when composting odorous material is a method known as '**capping' a pile**. This involves covering the entire pile with 6-12 inches of a high carbon material which will act as a 'biofilter' for odors. This can be an effective strategy as well if a pile needs to be turned, but the wind is blowing towards sensitive receptors (neighbors).

A template Odor Management Plan is found in Appendix B, and may be adapted by the farm to their operation.

Appendix A

Windrow/Pile Temperature Monitoring Record

Windrow or Pile Number: ______________________________ Date Constructed: ____________

Ingredients and Comments: ____

____

Date	Time	Moisture Rating	Odor Rating	Wind Direction	Temperature (°F) / Distance from End of Pile (ft)				Turned?	Rain or Water Added?

Appendix B

Agricultural Composting Odor Management Plan

Farm Name: ____________________

Address: ____________________

Operator Name: ____________________ Phone Number: ____________________

Email Address: ____________________ Date: __________

Overview

This document outlines management practices this farm will use to avoid problem odors associated with on-farm composting, and steps which will be taken if problem odors arise. It guides the operator in preventing problem odors, and troubleshooting them should they occur.

THE PLAN HAS THREE PARTS:

1. **Preventative Management**, based on sound composting procedures.
2. **Odor Evaluation and Remediation Procedures**, utilizing tables the farm will refer to in assessing and responding to an identified odor.
3. **Neighbor Complaint Acknowledgement Form**, used to document odor complaints, and the farm's corresponding management response if necessary.

1. Preventative Management

The farm's core management practices are outlined below. Additionally, the farm will refer to and comply with Massachusetts Department of Agricultural Resources *Guide* to *Agricultural Composting.*

COMPOST RECIPE

The farm will develop and adhere to a compost recipe that falls within the following industry accepted targets:

- C:N Ratio of 25-40:1
- Moisture Content between 50-65%
- Bulk Density of less than 1,000 Pounds/Cubic Yard

RAPID INCORPORATION

Vector attracting or high odor potential feedstocks will be immediately mixed with high carbon material upon delivery, which will contain and stabilize odor-causing compounds, ensuring establishment of active aerobic composting, and prevent access by potential vectors.

PILE CAPPING

Piles containing vector attracting or high odor potential feedstocks (food waste, for example) will be "capped" as needed with at least 6" of an odor absorbent, high carbon material (wood chips, shavings, leaves, high carbon horse bedding, etc.).

LEACHATE PREVENTION AND CONTROL

Leachate, or the loss of 'free moisture' from a compost pile, is nutrient rich liquid, and can be a source of contamination and odors on a compost site. Every attempt will be made to avoid and control leachate through proper recipe development, blending and pile monitoring, pile size and shape. Windrows will be long pyramid shape, to shed rainfall. During periods of excessive rain, recipes will be modified with a lower starting moisture content to increase the blend's capacity to take up precipitation without releasing leachate. Regular visual inspection of the piles will detect the presence of leachate and will allow the operator to identify the source and remediate it. If leaching does occur, a berm of sawdust, wood chips, finished compost, or other absorbent material will be constructed immediately downslope of where the leachate is originating, to contain and absorb the leachate. Saturated material will be incorporated into a windrow and composted. Ponding on-site will be avoided, and ponded areas will be regraded if necessary.

PILE MONITORING

Active composting piles will be monitored (and recorded) at least twice per week to determine the pile's level of biological activity and identify any problems which may arise. Monitoring records will be kept, documenting results, and any corrective actions necessary, as well as to document sufficient heat treatment for pathogen and weed seed destruction. Monitoring records will be stored in a safe, dry location for at least three years. Monitoring will include assessment and documentation of the following parameters:

- **Temperature** – A three-foot compost temperature probe will be used to monitor the composting materials. Temperature checks will be done in the middle of the pile (vertically) every 15-20 feet at depths of one and three feet in each location and recorded.
- **Moisture** – The simple "squeeze test" will be used to monitor the moisture of the piles. The target moisture content is 50-60%, which has the moisture properties of a "wrung-out sponge" when squeezed. If significant moisture issues are noticed, the cause will be identified, and the issue will be addressed promptly.
- **Odor** – The operator will observe and monitor any odors generated by the site and/or individual piles. This will be done every time the site is visited. During pile monitoring, piles will be rated as: No odor, minimal odor, moderate odor, strong odor, with a description of the character of the smell. If significant odors are noticed, the cause will be identified, and the issue will be promptly addressed following the procedures outlined in the Odor Evaluation Procedure section of this document.
- A visual inspection of the site and the piles will be conducted whenever the operator enters the site. These inspections will note if there is excessive moisture on the site and where it is coming from, the size and shape of the piles, signs of vectors (or materials or conditions that might attract vectors), and any other signs of potential problems. If problems are noticed, the cause will be identified, and the issue will be promptly addressed following the procedures outlined in the Odor Evaluation Procedure of this document.

ADDITIONAL STEPS

1. The farm will be responsive to neighbor's concerns and/or complaints, be specific and realistic about the causes, responses, and timeline for remedying the problem.
2. If the cause of the odor or nuisance cannot be easily identified or if it is present in a large volume of material, the farm will:
   a. Contact a technical consultant.
   b. Contact relevant state and local agencies to make them aware that there might be a problem.
   c. Work with the consultant and state to create and implement a remediation strategy.
   d. Maintain communication with any affected parties.

2. Odor Evaluation and Remediation Procedures

The following tables will be used to assess and remediate identified odors and to create a prevention strategy going forward.

1.0 Anaerobic Conditions, Leachate				
Identified Issue	**Cross-Check**	**Root Causes**	**Remediation Actions**	**Preventative Actions**
Problem Odor	Anaerobic pile conditions?	High moisture content (Lack of moisture in original recipe).	Blend in dry matter.	Adjust recipe to lower moisture content.
			Decrease pile size.	Construct smaller piles.
			Turn pile to dry.	
		Dense pile conditions (Lack of large structural particles in original recipe and/ or Infrequent turning/ mixing).	Blend in porous bulking agents (wood chips, grindings).	Adjust recipe to add porosity (5-15% woody chip/ grindings by volume).
			Turn pile to loosen and aerate.	Ensure thorough blending.
				Turn more frequently.
		Large piles inhibiting passive aeration.	Decrease pile size.	Construct smaller piles.
	Leachate from pile?	High moisture conditions.	Absorb leachate with dry carbonaceous materials.	Maintain pile moisture in target range.
				Ensure site infrastructure creates adequate drainage.

1.1 Problem Feedstock

Identified Issue	Cross-Check	Root Causes	Remediation Actions	Preventative Actions
Problem Odor	Problem feedstock?	High protein.	If odor is not controlled after capping, remediate recipe with carbon materials and bulking agent and re-cap.	Develop targeted recipe for problem feedstock. Significant sources of available carbon and porous bulking agents will be needed.
		High moisture.	If odor is not controlled after capping, remediate recipe with dry matter and bulking agent and re-cap.	Develop targeted recipe for problem feedstock. Dry matter and porous bulking agents will be needed.
		Low or high pH.	If odor is not controlled after capping, remediate recipe moisture content and density, then re-cap and leave unturned until pH is buffered by composting process.	Control carbon to nitrogen ratio and moisture content to minimize high protein (N), high moisture, and low pH conditions or high protein (N), low moisture, and high pH conditions.
		Specifically challenging compounds or feedstock.	Find technical support if traditional odor management techniques fail.	Use lab testing of feedstocks to develop targeted recipe for problem feedstock.
				Trial feedstock on a small scale before introducing a large volume to the composting operation.

1.2 Weather Factors

Identified Issue	Cross-Check	Root Causes	Remediation Actions	Preventative Actions
Problem Odor	Wind direction?	Strong odors escaping piles are likely to travel off-site.	Use cross-checks to implement immediate odor remediation to piles. (Tables 1.0-1.1)	Observe wind and odor generation patterns to minimize turning and avoid odor release coinciding with wind transport in directions of receptors.
				Install a weather station or windsock to monitor wind direction.
	Air inversion?	Normal air movement patterns are stagnant, trapping odors low to the ground, and magnifying nuisance potential.	Use cross-checks to implement immediate odor remediation to piles. (Tables 1.0-1.1)	Minimize turning in morning and evening when ground level inversions are common.
				Observe weather and odor generation patterns to minimize turning and avoid odor release coinciding with inversion conditions.
				Understand topological factors such as air drainages that can move and trap odors.

NEIGHBOR COMPLAINT ACKNOWLEDGMENT FORM

Date of Complaint: ____________Name of Neighbor/Complainant:______________________________

Address of Complainant: ____

Contact Information of Complainant: ____

Nature of Complaint/Issue (Please include location, dates, weather, or other relevant information):

____

____

Complaint Received and Acknowledged by:_______________________________ Date:_____________

COMPLAINT FOLLOW UP

Date: ___________Name of Person Responding to Complaint:_______________________________

If Complaint Regards an Odor:

Observed On-site? ☐ Yes ☐ No | ☐ Minimal Odor ☐ Moderate Odor ☐ Strong Odor

Observed Off-site? ☐ Yes ☐ No | ☐ Minimal Odor ☐ Moderate Odor ☐ Strong Odor

Identified Cause?

Date and Time First Detected: ___________________ Date and Time Ended:___________________

Single or Recurring? ___________________ If Recurring, at What Frequency?___________________

Immediate Action Taken on Complaint: ____

____

____

____

Long Term Plan for Remedial Action: ____

____

____

____

Follow Up Date with Complainant:____

Results of Remedial Action: ____

____

____

Acknowledgements

The purpose of this Guide is to encourage and safeguard agricultural composting.

This Guide was originally written by Sumner Martinson of MassDEP and the late Maarten van de Kamp of MDAR. It was updated in 2010 by Saiping Tso of MDAR, and further revised in 2023 by Sean Bowen to reflect MDAR regulatory changes.

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