BEST MANAGEMENT PRACTICES
FOR
ANIMAL CARCASS COMPOSTING

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Maine Department of Agriculture, Food and Rural Resources

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Introduction

Maine's Animal Carcass Disposal Rules, Chapter 211, allow for the use of composting as a method for managing animal carcasses generated on farms and farm operations. (The rules also apply to composting of pets and other domestic animals.) When the rules were drafted and adopted in 1996, composting was applied primarily to poultry and other small animals. As a result of the Foot and Mouth Disease outbreak in Great Britain in 2001 and other disasters that left hundreds or even thousands of large animal carcasses, there has been interest in extending this methodology to larger animals.

Research and demonstration work has been conducted in Maine and in several other states since that time. Work by the Maine Compost Team (see references) demonstrated that large animal carcasses can be successfully composted using a variety of compost feedstocks. The research led to the development of the approach called 'Pre-condition and Turn' which has been tried on a variety of different carcass types. This work has shown that composting is a feasible and in many cases a preferable approach to managing larger carcasses. In many situations, burial is discouraged due to shallow soils or water tables near the surface or due to any number of other factors that render a site unsuitable for burial. Often, these same sites may be used for composting. One advantage often cited is the ability to reuse the compost site over and over, unlike burial sites which should not be used again for many years.

The 2011 update to Chapter 211 contains references to a number of carcass composting techniques and sets standards for siting and operation of each. This document contains the basic information on materials and pile construction and management techniques needed to properly implement several of these composting approaches. Special attention is given to the technique that is referred to as the 'Pre-condition and Turn Method' since that appears to be the most versatile method of composting animal carcasses and applies to the widest range of circumstances. Two other techniques, the static pile and the turned windrow, are also discussed. Information on how to set up and manage a Maryland Bin system is also described. Anyone interested in pursuing that approach will find more detailed information available in publications listed in the Bibliography.

This set of best management practices (BMPs) is the accumulation of information about composting techniques that have been found to be environmentally sound, economical to implement and are unlikely to result in significant nuisance problems if carried out

properly. As with any new area of research and demonstration, there is still much to be learned about this process, so that updates of these BMPs are likely over time.

Definitions

Animal Carcass(es) - Body(ies) or body parts of dead animals, including but not limited to pets, livestock and poultry. Carcasses may be mixed with manure and bedding or other organic materials which cannot be separated from the animal carcasses.

Animals/ carcasses, Large- Animals such as cows and horses weighing 500 lbs or more.

Animals/ Carcasses, Medium-size - Animals such as sheep, goats and deer weighing between 100 and 500 lbs.

Animals/ carcasses, Small - Animals which weigh 100 lbs. or less.

BMP - Best Management Practice - The term "Best Management Practice," or BMP, originated in the Clean Water Act of 1972, and is now commonly used in the language of environmental management. In agriculture, these are practices, methods or techniques that have been found by the Commissioner of Agriculture to be the most effective and practical means in achieving an objective (such as preventing or minimizing pollution or negative impacts on human or animal health) while making the optimum use of the farm's resources.

BMP, General - Best Management Practices that have been approved by the Commissioner of Agriculture for general use. A list of general BMPs serves as a menu of acceptable options that the farmer, business owner or individual may choose from. Not all general BMPs would apply to any specific situation.

BMP, Site Specific - Best Management Practices that are developed or approved by the Commissioner of Agriculture to resolve specific problems based on the conditions observed on a particular site.

Bulking Agent - Relatively dry porous material used to give a compost pile structure and to absorb moisture. Most bulking agents are relatively high in carbon and so are also a carbon source. Examples of bulking agents are sawdust, shavings, dry animal bedding and straw.

Compost Medium/Material - The relatively dry bulky organic material that forms the matrix within which carcasses or offal are composted.

Composting - The biological decomposition and stabilization of organic matter under mostly aerobic conditions of high temperature (120°F or higher). When oxygen, moisture, nitrogen and carbon are available in the right proportions, the degradation generates considerable quantities of heat, reaching temperatures of 130° to 170° F. This sustained high temperature is responsible for the virtually complete destruction of

pathogenic organisms and weed seeds in the composted material. The process also results in a humus-like product that has its nutrients in a much more stable form than the uncomposted wastes making it safer and easier to store and use.

Chronic Wasting Disease -A neurological disease of members of the deer family. (See Transmissable Spongiform Encephalopathy (TSE))

Emergency - An unexpected occurrence or set of circumstances demanding immediate action, eg. fire, major disease outbreak, flood, etc. An emergency exists when multiple carcasses result from a single, unplanned occurrence, such as a fire, disease outbreak, flood or other disaster.

Offal - Unwanted or unused body parts remaining from butchering or slaughtering animals.

Scrapie - A neurological disease of sheep and goats. (See Transmissable Spongiform Encephalopathy (TSE))

Transmissable Spongiform Encephalopathy (TSE) - One of several similar neurologic diseases thought to be caused by a mis-folded protein (prion) in the nervous tissue which results in slow degeneration of the nervous system and ultimately in death. These diseases include Scrapie, 'Mad Cow Disease' and Chronic Wasting Disease.

Applicability.

The primary approach described in this document is the 'pre-condition and turn' method of composting that has been developed as a result of the research noted above. This approach is suitable for composting large animal carcasses as well as smaller animals. It may also be adapted for composting animal parts such as those generated from slaughterhouses and butcher shops. The pre-condition and turn approach is well suited to either routine disposal or large scale disaster disposal situations. Although the other methods described may be used in all these situations, each has certain limitations in some scenarios. For example, the Maryland Bin System would be impractical to set up in an emergency situation since there would not be time to pour cement and construct enough bins to handle a large mortality event. On the other hand, the turned windrow system does not lend itself well to composting large carcasses unless they have been cut into smaller pieces that can be mixed with a compost medium and turned. In instances where the carcasses are the result of a disease outbreak, certain materials and methods are preferred over others. These will be identified in the sections addressing these items.

Description of Composting Systems

Several compost systems are available. The most common are the University of Maryland Compost Bin System, the turned windrow system, the aerated static pile

system, the pre-condition and turn system and in-house composting. A less common approach is the use of some type of in-vessel system.

a. **University of Maryland Bin System** - The University of Maryland Bin Composting System uses wooden or concrete block bins to compost poultry, other small carcasses or poultry offal. The composting is done in two active stages plus a curing stage. This system only applies to small carcasses or small body parts. (Other bin systems are also possible.)

b. **Turned Windrow** - The turned windrow system is an approach, in which the compost mixture is placed in rows and turned periodically during the compost cycle. The turning action supplies oxygen through gas exchange, thereby creating natural ventilation. The frequent turning insures the production of a uniform product at the end of the compost process. Success with this system depends on the ability to achieve a thorough mix and aeration through repeated turning. This system only applies to small carcasses, small body parts or ground carcasses.

c. **Static Pile -** The static pile method uses a pile of composting material that is not agitated or turned. The initial thorough mixing of the carcasses or body parts with the compost media is essential to create a uniform mix and contact between all carcasses and the media. Porosity in the pile must be sufficient to allow proper air flow and effective composting. Aerobic conditions are maintained by natural ventilation of the pile that is enhanced by using materials that maintain a relatively high pile porosity. The pile is covered with an insulating blanket of four to six inches of finished compost, compost media, or other suitable material to ensure proper temperatures are attained at outer edges of pile. This approach applies primarily to poultry and other small carcasses.

d. **Aerated Static Pile -** In the aerated static pile method (also known as the Beltsville Method or Rutgers Method), the compost is not agitated or turned. The initial mixing of the carcasses with the bulking agent must be sufficient to allow proper air flow and effective composting. Aerobic conditions are maintained by mechanically drawing, or blowing air through the pile. The pile is covered with an insulating blanket of four to six inches of finished compost, compost media, or other suitable material to ensure proper temperatures are attained at outer edges of pile. This approach applies primarily to poultry and other small carcasses.

e. **Precondition and Turn Method** - The pre-condition and turn system was developed specifically for management of animal carcasses and slaughterhouse wastes. In this method, the carcass or body parts are placed between layers of dry absorbent bedding or other compost media. The carcasses or body parts are then allowed to decompose without disturbance for a period of time, which varies with carcass size and other factors. (See Table 1.) Once this pre-conditioning period is done, the pile or windrow is then turned similar to the turned windrow system. This method may be used for both routine and emergency situations and for both large and small carcasses and slaughterhouse wastes (offal) of all types. It has the advantage that early in the process, the carcasses or offal remain buried deeply in the compost media until a significant

amount of decomposition has occurred. This significantly reduces nuisances in these early stages, but allows the advantages of thorough mixing and aeration in the later stages.

f. **In-house Composting -** This option uses one of the windrow or pile based compost methods such as the turned windrow or the pre-condition and turn approaches except that the windrow or pile would be formed inside the barn using the litter from the barn and, usually, some additional bulking agent as the compost medium. This approach applies primarily to poultry that are raised on the floor of the poultry barn with litter although it could also be used for other small or medium size animals kept in loose housing.

g. **In-vessel Composting -** Many different in-vessel compost systems have been developed for a variety of purposes. Some are static systems with air introduced with blowers. Others are mechanically agitated or tumbled to mix and aerate the contents. The common factor in all these systems is that the composting is done within a container. Several compost systems that incorporate some type of vessel in the compost process are available. Most of these systems use some form of active aeration to provide the needed oxygen. One system that has been used to compost poultry.mortalities from an avian influenza outbreak utilized the large plastic 'bags' designed for feed storage with aeration tubes inside. These systems offer the advantage that they are completely enclosed and so promise greater control over odors, vectors and loss of leachate than open windrow methods. Most of these systems are best suited to small carcasses or carcasses that have been ground or cut into pieces.

Siting Carcass Compost Operations

Because carcass composting has the potential to impact the environment, most states have standards for locating carcass compost sites. The standards include setback distances to sensitive features such as water bodies and separation distances to groundwater and bedrock. Maine's standards are spelled out in Tables 4 through 8 at the end of the Chapter 211 Rules. Composters are advised to check with the standards for their own state prior to establishing a carcass compost site.
Here is some general guidance in siting a compost facility:

1. Excess water is the composter's enemy. Setting up your site to be sure that the compost is never sitting in water and that your equipment is not working in mud is a key to successful composting.

2. The soil or other working surface should have a minimum slope of 2 percent and a maximum slope of 6 percent that slopes to move water off from the site rather than let is stand. Sites on natural soils need to have a little more slope than paved sites since ruts are more likely on the soil surface.

3. Composting sites should be located as near the source of carcasses as practical and in accordance with the regulatory setback requirements. (For Maine composters, the

requirements are laid out in the Carcass Disposal Rules, Chapter 211.) Whenever possible, the siting should also be done so that the prevailing winds will not carry odors from the site to nearby neighbors.

4. Surface water should be diverted away from the facility.

5. The compost pad and any area surrounding it that will have equipment traffic should be designed so that it can handle traffic involved in the compost process.

6. You should have a vegetated filter strip or other approved area downslope from the compost pad to receive and treat any leachate or runoff that might be generated.

Space Requirements

Once a potential compost site has been identified, the amount of space required to accommodate the number of carcasses should be calculated. See Diagram 1 for guidance in doing this calculation for large animal carcasses. For medium size carcasses, assume that the space requirements per animal will be about half those for a large carcass. Space requirements for small carcasses should be based on an animal unit basis, where each 1000 lbs of small carcasses is the equivalent of one animal unit. The guidance in Diagram 3 may be used to estimate space for small animal carcasses by replacing one carcass with one animal unit. Once this is done, the site should be checked to be sure sufficient space is available. If it is not, an additional area(s) will need to be identified.

Materials/ Compost Media for Animal Carcass and Offal Composting

The media used for composting carcasses or offal should provide the conditions that will support hot aerobic composting

Characteristics: Animal carcasses and offal can be successfully composted in a variety of media. The ability to achieve temperatures proven to kill most pathogens will depend more on the conditions in the media than on the source of the media. Those conditions that appear to be most conducive to rapid and sustained heating are:

a. Porosity – The compost media should have sufficient porosity that it will allow air to be drawn into the pile through natural ventilation but not so porous as to cause excessive drying or cooling. Piles with a predominance of very fine textures or very wet materials fail to heat due to lack of oxygen. Piles with a very high porosity, such as wood chips, heat rapidly but are unable to sustain the high temperatures. Mixtures having a large proportion of particles between 1/8 inch and one inch appear to give the optimum results.

b. C:N ratio – As with all composting, piles with C:N ratios too high (over 40:1) tend to heat slower than those with a lower C:N. In order to accommodate the

nitrogen from the carcass, the C:N ratio in the compost media should be between 25:1 and 50:1, with the preferred range being between 25:1 and 40:1.

c. Moisture - The compost media should have a moisture content between 40 and 65% with the preferred range being between 50 and 60%. This may be assessed through the use of the squeeze test or other acceptable test procedures. A material that is so wet that water will run out when squeezed is not likely to aerate well and will result in anaerobic conditions in the pile.

d. Biological activity - The compost media should be biologically active such that it will reach temperatures of at least 120°F when placed in a pile at least 6 ft (two meters) in diameter and 3.5 ft (one meter) high. Materials such as sawdust or woodchips that have limited biological activity and will not heat on their own should be amended with other ingredients (such as manure or waste feed) to create a biologically active environment.

e. Age of material – The compost media for carcass composting should be fresh, active material. Materials that have been composting for several months do not have the amount of energy or activity needed to sustain the temperatures within the carcasses when compared to relatively fresh active compost piles.

Compost Media Recommendations for Animal Carcasses. The following media have been tested and found to give excellent results for composting animal carcasses and offal:

- hot municipal sludge compost
- fresh dry horse bedding
- mixture of waste feed (1/4 to 1/3 of the mix) and dry horse, heifer or calf bedding(2/3 to 3/4 of the mix)
- mixture of fresh fall leaves and poultry manure (in a ratio of 10 to 1 leaves to manure)

NOTE: Hot municipal sludge compost is recommended in emergency situations in the State of Maine since it is readily available in large quantities and has been proven to create the conditions necessary to compost both large and small carcasses.

Any other media that meets the requirements in the section above should also perform well for composting either carcasses or offal.

Compost Management

Processes. Several compost systems or processes are discussed in this document. The process recommended for most situations may be described as a static compost pile followed by the turned windrow method. In Maine, this has been named the 'Precondition and Turn Method' of composting. In this system, a large carcass or carcasses would be placed in a pile of actively composting material and allowed to

decompose undisturbed for up to 10 to 12 weeks. (This can be shorter if investigation of the pile shows that very little soft tissue remains.) Other systems discussed in later sections include the static pile system, turned windrow system, the Maryland Bin System, in-vessel composting and in-house composting.

Turning. Compost piles are often turned to mix the various ingredients and to introduce air space to allow for aeration. This may be done with a tractor or other piece of equipment with a loader. Compost turning machines that are designed specifically for this purpose are also available.. Turning may be problematic early in the compost process because of the difficulty of moving the carcasses while keeping them properly covered. Many compost turners would not be able to turn an object the size of a large farm animal while it was intact. After turning, care should be taken to make sure there is no soft tissue on the surface of the pile. Bones on the surface of the pile with any soft tissue should be reburied in the compost pile immediately. (Note: Static pile systems and many in-vessel systems do not include turning as part of the process.)

Odor, insect and vector control . Animal carcass compost sites and operations should be managed to minimize odors and the attraction of insects and other vectors. The first step toward doing this would be to make sure no carcass is left uncovered long enough to attract vectors. Generally, if carcasses are covered within 6 hours vector attraction will be minimal. Offal, however, is more odorous so that it attracts vectors quicker and should be covered as soon as possible. (Note: Maine's carcass disposal rules, Chapter 211 require that carcasses be covered within 24 hours and that offal be covered within four hours.). Proper pile construction with sufficient material both below and above the carcass is critical. (See pile construction section.) Good pile management and good housekeeping are also very important. As the carcass(es) decomposes, especially within the first 5 or 6 days, the pile is likely to settle dramatically. It is essential to check the pile and re-cover any part of the carcass(es) that may become exposed. The settling process may also create cracks in the material, especially just above the carcass(es). These cracks should be filled since they can form channels for odor to escape the pile, attracting insects, birds, dogs and other scavengers.

In some cases, it may be necessary to discourage animals such as turkeys, dogs or coyotes from digging in fresh piles. Draping the orange plastic 'safety fencing' over freshly built piles has proven to be an effective deterrent to digging.

Types of Carcasses. Compost techniques have been successfully used with adult cattle, calves, horses, pigs, sheep, poultry and other less common types of farm animals. Some work has also shown success with composting large marine mammals. At this time, composting is not being recommended for the disposal of animals showing symptoms of neurological diseases such as Chronic Wasting Disease or Scrapies. Research is currently being done to assess the extent of destruction of the causal agent for these types of diseases so this recommendation may change in the future.

Carcass Preparation . In general, no preparation is necessary for the most compost systems to work. In many cases there are a couple of steps that may be taken to

enhance the composting process. 1. Venting the abdomen of large animals helps reduce bloating and so reduces the chance of exposure of parts of the carcass in the first few days of the compost process. For cattle, effort should be made to vent the abdomen in several places since a single vent hole will not release gas from all parts of the abdomen. 2. Some farms have reported that cutting a large carcass, such as a dairy cow in half or quarters speeds up the decomposition process. A modification of this would be to split open the abdomen to allow more contact with air and the compost mixture.

Neither venting nor cutting isrequired for the overall success of this process. In the case of carcasses with highly contagious diseases, such as Foot and Mouth Disease, it is recommended that the carcasses not be vented or cut in order to minimize the chance of transferring the disease organism.

If large or medium size carcasses are to be composted using a turned windrow system, then grinding the carcasses or reducing them to smaller pieces in some way is highly recommended. Otherwise turning will be very difficult at the outset.

Pile Construction and Management.

Proper pile construction is a key to composting animal carcasses without causing environmental problems or nuisances. Diagrams 2 and 3 illustrate the recommended approach to constructing compost windrows for large animal carcasses. Diagrams 4 through 6 illustrate the recommended layout for medium size carcasses, small carcasses and offal, respectively. Diagrams 7 through 9 illustrate the layout for Turned Windrow, Static Pile and Maryland Bin systems.

Taking Temperatures

Systematically taking and recording temperatures is an important tool in managing any kind of compost pile. Here are the MAINE COMPOST SCHOOL RECOMMENDATIONS for taking pile temperatures:

1. For a Windrow:
TAKE 5 OR MORE READINGS FOR EACH WINDROW
READINGS SHOULD BE EVENLY SPACED ALONG THE WINDROW
RECORD INDIVIDUAL READINGS AND AVERAGE FOR THE WINDROW
TAKE READINGS FROM SAME LOCATIONS EACH DAY!

2. For a Round Pile:
TAKE 2 OR MORE READINGS
READINGS SHOULD BE FROM OPPOSITE SIDES OF PILE
RECORD INDIVIDUAL READINGS AND AVERAGE FOR THE PILE
TAKE READINGS FROM SAME LOCATIONS EACH DAY!

3. At each location, TAKE TEMPERATURES AT DEPTHS OF

1 FOOT(30 cm) - HOTTEST LEVEL
3 FOOT (1 meter) OR CORE
RECORD TEMPS AT EACH DEPTH SEPARATELY

You should record the pile temperatures as often as possible, preferably every day you are on the compost site. Keep in mind that you will need to keep records at least until a pile meets the time/temperature requirements in CHAPTER 211. In addition to pile temperatures, you should record management information such as pile turning or addition of water or other ingredients. To complete the record, you should keep track of any rainfall or other significant weather event that has happened since the last time temperatures were recorded. This will help in interpreting your temperature data when you look at it at a later date.

Meeting Time/Temperature Standards.

In order to distribute compost made from animal carcasses to the public, the compost process must meet certain time and temperature standards. These standards differ depending on the type of compost system being used. Maine's time/temperature standards as laid out in Chapter 211 are as follows:

1. **Maryland Bin Composters -**: Temperature shall be monitored and recorded on a daily basis at least until the time/temperature standard has been met. Temperature readings shall be taken at a point near the center of the bin. The compost shall attain a minimum temperature of 131° F (55° C) for a minimum of one day in Stage I and for a minimum of three days in Stage II. Batches that fail to meet this temperature requirement shall be incorporated into subsequent batches and re-composted or be spread on the owner's land;

2 Windrow Composting Method - Temperature shall reach a minimum of 131° F (55° C) for at least 15 days during the composting period. During the high temperature period there must be a minimum of five (5) turnings of the pile. Once this temperature requirement is met, the windrow shall be turned at least once per week. Once the temperature in the windrow drops below 110°F and does not increase after turning, the windrow may be placed in a curing pile.

3. Static Pile or Aerated Static Pile.. The pile shall be maintained at a temperature of 131° F (55° C) or greater for at least three (3) days at both the three foot and one foot depths in the pile. Detention time in the static pile or aerated static pile shall be at least 21 days, after which the pile may be dismantled and moved to curing;

4. Pre-Condition and Turn Method. The compost shall attain a minimum temperature of 131° F (55° C) at the three foot depth at each location for a minimum of three days in the pre-condition stage (Stage I) or for a minimum of fifteen days at either depth during the turning stage (Stage II). The windrow must be turned at least five times during the high temperature period.

5. In-vessel Compost Systems. The contents of the vessel shall be maintained at a temperature of 131° F (55° C) or greater for at least three (3) days throughout the vessel. The composting mixture shall remain in the vessel until all soft tissue is gone but in no case shall it be retained for less than 21 days, after which the contents may be removed to a compost pile or placed in curing;

Minimum Volumes

For all composting methods other than the Maryland Bin System, a minimum pile volume of five (5) cubic yards is required for the process to be effective. Piles with larger carcasses will, of course, require a much larger volume in order to adequately cover the carcass (es). See the pile construction diagrams at the end of this document for guidance in estimating volumes needed.

Curing

For all compost systems, the compost should be cured for three(3) to six(6) months once the active compost phase has been completed or after the pile has cooled to less than 110° F(43°C). Compost that is to be field applied may be utilized immediately after the active compost stage or may be cured for a shorter time before use.

Pre-condition and Turn Method Step by Step Process

Step 1. Lay out a bed of dry compost media mix. It is important to make sure there is at least 18 inches of dry absorbent material below the carcass. This minimizes the amount of fluids that are released as the animal decomposes from reaching the ground water or exiting the pile. The bed of material upon which the carcass is laid, should extend at least two feet beyond the carcass in every direction. For most dairy cows, this would require a bed about 8' by 10' – 12'. The size will need to be adjusted based on the size of the carcass.

If multiple carcasses are to be composted at the same time, the base of a windrow can be formed by creating a bed about 8 to 10 feet wide and as long as needed to accommodate the number of animals to be composted. See Diagram 1.

Step 2. Place the carcass on the bed of compost material. The carcass should be laid on its side to reduce the chance that the legs will be exposed as the pile settles. For a single animal, the carcass should be oriented so that the length of the body is going lengthwise of the pile.

If multiple carcasses are to be composted at the same time, a windrow can be formed. It is recommended that carcasses be laid at right angles to the orientation of the windrow and placed so the body of one overlaps the legs of the adjacent carcass. This helps reduce

the overall length of the windrow needed and the amount of compost material needed. See Diagram 1.

Step 3. Prepare carcass, if desired. This is the most convenient point in the process to vent the carcass, open it up or to insert a thermometer, if any of those steps are to be taken.

Step 4. Cover carcass(es) with at least two feet of compost material. To be sure that at least two feet of cover is present over all parts of the carcass, the equipment operator or preferably someone working on the ground should probe all parts of the pile to determine how deep the carcass is buried. A three foot long compost thermometer makes a good probe, as does a length of sharpened steel rebar. Any type of rod that is at least three feet long and has a tapered end will work.

When composting carcasses in the winter, additional cover material will be needed to maintain pile temperatures. An additional six to twelve inches of cover material will insulate the pile and allow the core of the pile to stay warm and active for much of the winter.

Step 5. Monitor the pile regularly, especially for the first 4 or 5 days. An active carcass compost pile will change dramatically over the first week of composting. Piles often settle a foot or more and sometimes develop cracks that can lead to odors and attract animals and insects to the pile.

Step 6. Maintain the pile as needed. If a crack appears in the pile or if any of the carcass becomes exposed, or if there is any animal activity, the pile will need to be repaired. This usually consists of either raking material into the cracks or adding more material to cover exposed parts and to discourage scavengers. Any of these conditions should be corrected as soon as possible since they can lead to greater problems if left uncorrected.

Step 7. Pre-condition the carcass(es). To do this, allow the pile to compost undisturbed for for several days to several weeks depending on size and type of carcass or offal. See the table below for suggested lengths of time for different carcass types. The pile may be left for up to six months if turning is impractical at the end of the pre-condition period. Some piles may be ready to turn in shorter time. This can be determined by digging into the pile to determine the level of decomposition. The length of the pre-condition period can vary considerably based on the level of energy in the compost medium, the size of the carcass and the time of year.

TABLE 1 SUGGESTED LENGTH OF PRE-CONDITION PERIOD FOR CARCASSES AND OFFAL

Type of Material	Length of Pre-condition Period (Days)
Poultry offal	7 to 10
Large animal offal	20 to 25
Large animal offal with bones	25 to 40
Poultry and other small carcasses	25 to 35
Deer, goats, sheep and mid size carcasses	35 to 45
Cows, horses and other large carcasses	40 to 90

Note that these suggested pre-conditioning time periods are based on the use of an active, hot compost medium. Pre-conditioning times may increase dramatically if the medium is old, wet, extremely dense or otherwise inhibited in activity.

Step 8. Turn the pile or windrow. The pile or windrow may be turned with a bucket loader, excavator or any other piece of equipment that will lift, fluff and mix the material. A compost turning machine would be ideal for this purpose. Turning should be done about once a week for as long as the average pile temperature is above 110° F. At least two turnings are recommended even if the temperatures are below 110° F when it is time to turn the pile or windrow for the first time. For more detail on determining turning schedules, see the section on Aeration for Turned Windrows.

Step 9. Cure the compost. Once the pile has cooled to less than 110° F (43°C), it may be placed in a larger stockpile to cure. Curing normally takes from 3 to 6 months after the active compost stage is done. Compost that is to be field applied may be cured for a shorter time or applied immediately after the active composting stage.

Turned Windrow.

In general, a turned windrow system is not recommended for fresh whole large or medium size carcasses for a number of reasons. A turned windrow may be used, however, if grinding equipment with sufficient capacity to handle a whole carcass is available. A turned windrow may be used for smaller animals such as chickens since it may be possible to mix them with the compost media and then be turned on a regular basis. In order to avoid nuisance and vector problems, it would be necessary to pick up any carcasses that fall out of the windrow during turning and then re-bury them in the compost media. The windrows may have to be re-covered with compost following the first few turns to make sure that all carcasses are buried deeply enough in the pile. This extra work of repeated burying and covering makes the turned windrow system an unattractive option for most farms. (See the On-Farm Composting Handbook for details on managing a turned windrow compost system.)

Mixing for Turned Windrows. The mixing of ingredients in a turned windrow may be done in two ways. If a mixing device such as a feed mix wagon is available, the compost materials may be premixed prior to forming them into a windrow. This approach is preferred for carcass composting since the carcass(es) can be buried in a fully mixed medium at the start. If no mixing device is available, the ingredients can be laid out as in Diagram 7 and then mixed with a bucket loader or windrow turner.

Pile Construction for Turned Windrows. Windrows that will be turned may be laid out the same as those that will be managed using the pre-condition and turn system. See Diagrams 2 through 6 for windrows built using a pre-mixed compost medium. Or they may be laid out as in Diagram 7 if the ingredients in the medium are not going to be pre-mixed.

Aeration for Turned Windrows. Aeration in a windrow system in general occurs as a result of the natural intake of air along the sides of the windrow as the pile heats and vents the hot air out the top of the windrow. The ease with which this happens depends on the porosity of the compost medium. As the windrow or pile composts, it settles, thus increasing compaction and reducing porosity. Periodically, it it necessary to fluff up the compost material to re-introduce the air space into the pile to allow it to continue to 'breathe'. This can be done by lifting and fluffing the material with a loader of some type or by turning it with a compost turner.

The frequency of turning in a turned windrow system can be determined based on time or on temperature. The initial turning schedule, however, may be determined by the need to meet certain regulatory requirements. In Maine, the Chapter 211 rules require that carcass compost being managed by the turned windrow method must achieve a temperature of 131° F (55°C).for a minimum of 15 days and that it will be turned at least five times while the temperature is at or above 131° F (55°C).

After this regulatory requirement has been met, the windrow or pile will still need to be turned periodically in order to facilitate the aeration process and maintain pile temperatures. Generally, if a windrow is turned once a week as long as temperatures remain at or above 110° F, the aeration needs will be met.

Those who want to base turning on temperatures may use the following rules of thumb to guide turning decisions:

- Turn whenever there is a significant drop in pile temperature from one day to the next and no external cause is apparent.
- Turn whenever the pile temperature exceeds some temperature threshold. An example might be to turn any time the temperature exceeds 160°F.
- Turn if the temperature reading at the one foot depth in the pile is more than twenty degrees F hotter than the three foot temperature.

For additional details on how to construct and manage a Turned Windrow System refer to the 'On-farm Composting Handbook'.

Curing. Curing in a turned windrow system is similar to curing in the pre-condition and turn system. Once the pile has cooled to less than 110° F (43°C), it may be placed in a larger stockpile to cure. Curing normally takes from 3 to 6 months after the active compost stage is done. Compost that is to be field applied may be cured for a shorter time or applied immediately after the active composting stage.

Static Pile and Aerated Static Pile

Mixing for Static Piles

Thorough up-front mixing of the compost ingredients is essential for success in static compost systems since the material remains undisturbed throughout the active composting phase of the process. This means that the ingredients must either be placed in a mixing device in the right proportions (see section on compost media) or layered in the right proportions and mixed with a loader. For static pile systems, a mixing device such as a feed mix wagon is highly recommended since a much more uniform mixture can be created than with a bucket loader.

Pile Construction for Static Piles

Once a thorough mix of ingredients, including the carcasses or parts, has been achieved, they should be laid out as shown in the Diagram 8. It is important that once the pile has been formed, a layer of compost, compost media or other dry bulky material be placed over the mixture. This layer not only insulates the pile allowing it to heat throughout, but acts as odor control. If sufficient cover material is not used, animals are likely to be attracted to the piles.

Aeration for Static Piles

Aeration for static piles may be either passive or active. The difference is that in active aeration, a blower would be used to blow or draw air through the compost mixture, while passive aeration depends on the natural flow of air in the pile caused by the heating of the material.

Passively Aerated

Passive aeration depends on the pile maintaining sufficient porosity throughout the compost process to allow the pile to naturally draw air in through the pile sides. In order for this to happen, the original mix must be made up of materials that will resist compacting as the pile settles and reduces in size. Generally, this means that there are components such as wood chips or coarse wood shavings that will continue to provide air spaces as the process progresses. A relatively low starting bulk density (about 800 lbs per cubic yard) for the mix will also be a benefit. Passively aerated piles may include aeration pipes under the piles to try to improve the amount of air flow in the pile. Results using aeration pipes under passively aerated carcass compost piles has had mixed results. Although early pile temperatures may be higher when using the aeration pipes, they have also led to more odor and vector issues since the pipes can act as conduits for liquids to leave the pile.

Actively Aerated

Actively aerated carcass compost piles would rely on using a similar mixture of ingredients as described in the passively aerated compost pile section above. These systems, however, all have either aeration pipes underneath the pile or an air plenum built into the floor of the compost area. These structures allow air to be blown into the pile mechanically. A key to using an actively aerated static pile is determining the number, size and scheduling for blowers. A common rule of thumb is to design a blower system to deliver approximately 10 cfm (cubic feet per minute) of air per dry ton of composting material based on continuous airflow. (Delivery rate would need to be higher for intermittent aeration schemes.) Blowers for this type of system generally are in the 1/3 to 1/2 hp size range. The 'On-farm Composting Handbook' has details on how to construct and manage an aerated static pile

Length of Time in Pile

Most regulations, including Maine's Chapter 211, that determine the minimum standards for carcass composting require that static piles remain undisturbed for 21 days or more. The rules then allow the compost to be moved to curing piles. Experience has shown that meeting this standard will result in pathogen and weed seed kill and will significantly reduce the vector attraction but the composting process is far from finished. Generally, temperatures in the static pile will still be well over 130°F (55°C) at the end of the 21 day period. Longer compost periods are recommended if a stable final product is the goal.

Curing

Curing is especially important for compost produced using either of the static pile systems since experience has shown that the material is not uniformly composted at the end of the nominal active composting period and may contain very immature active material in some locations. Allowing it to cure for three to six months will allow harmful constituents in the immature compost such as ammonia or volatile organic acids to further break down prior to use. For the curing to be effective, however, the compost needs to be moved from the original location and actively mixed and re-piled to allow the various parts of the pile to be homogenized.

Bin Systems.

A permanent bin system may be set up to accommodate routine mortalities on a farm. Generally, bins are sized and used for carcasses that are 300 lbs or less. Some mid-western farm operations, however, have successfully composted cow carcasses using large concrete bins with built in air ducts or temporary bins made from large round bales of hay. The dimensions of the bins should be determined based on the size of the carcasses to be composted and the equipment that would be used to unload the bins. (See reference section for publications about designing, building and managing bin compost systems.) One of the most commonly used bin systems was developed for the broiler industry by the University of Maryland. That system is used throughout the Southeastern United States for the disposal of poultry. Some of the basics are given below. More information on bin design, construction and management may be found in several references in the Bibliography.

Maryland Bin System

The University of Maryland Bin Composting System uses wooden (or sometimes concrete block) bins to compost poultry carcasses. The composting is done in two active stages plus a curing stage. Stage I begins by placing a 6" layer of dry poultry manure in the bottom of a bin then placing a 6" layer of straw, chopped hay or other loose bulking material, then poultry carcasses and a layer of manure. The straw, carcass, manure sequence is repeated until the bin is full. (See Diagram 9.) It is then allowed to compost for 7-10 days.

Stage II begins when the material that has been composting 7-10 days is moved into a second bin. The moving should be done so as to mix and loosen the material as much as possible.

After the material has been in the second bin for approximately 10 days, the highly active composting period is complete. The material may then be moved to a curing pile for 30 days.

1. Bin Construction - The compost bins must be built of decay-resistant wood or other durable materials. They are built on an impervious base and most have a roof to keep out excess moisture. Plans for bin construction are available from several sources (See Bibliography.)

Bins are typically 5' high, 5' deep and 8'+/- wide, with the width of the bin planned to accommodate the size of the equipment used to load and unload each bin. The second stage, or secondary composter, may consist of individual bins or one bin of the size equivalent to the sum of the individual bins.

2. Bin Volume - For each stage of the composting process, storage volume is calculated as follows:

a. Volume (cf) = Number of birds in flock x Design Factor (See Table 2)

b. Number of bins per stage = volume (from above) (cf)/volume of one bin (cf)

TABLE 2. DESIGN FACTORS FOR SIZING COMPOSTING BINS*

Poultry Type	Design Factor cu. ft./bird
Broiler	0.0105
Roaster	
• females	0.0071
• males	0.0214
Laying Hens	0.0035
Breeding Hens	0.0048
Breeders - Male	0.0238
Turkey	
• female	0.0196
• tom	0.0468
• feather production	0.0741

*From SNTC Bulletin S210-0-05

3. Operation of Maryland Bin systems

a. Temperature should be monitored on a daily basis. Temperature should peak at 130° to 140° F in each stage of the composting process.

b. At the end of each day that carcasses are placed in the bin, they should be covered with manure and bulking agent to reduce odor, fly and vermin problems.

c. The Compost mixture normally remains in primary (Stage I) bin for a minimum of seven (7) days after bin is filled and a minimum of seven (7) days in the secondary (Stage II) bin. After leaving the secondary (Stage II) bin, the compost should remain in a curing pile for at least 30 days before use or distribution. The material will still be active at this point.

d. To avoid fly and odor problems, carcasses should be placed at least 6" from the sides of composting bins.

e. The compost medium ingredients that are recommended by the University of Maryland age given in the table below. See the section on compost materials for additional ideas for materials that may be used.

f. Moisture in the composting material should be checked periodically and water added if it is not moist to the touch.

Composting Mix Ratio Recommendations for the Maryland Bin System

The mix ratio recommended by the University of Maryland and the Natural Resources Conservation Service is given below in Table 3.

TABLE 3. MIX RATIO RECOMMENDATIONS FOR MARYLAND BIN SYSTEM*

Component	Parts by Volume	Parts by Weight	C:N Ratio
Chicken Manure	1.5	1.2	15:1
Dead Birds	1.0	1.0	5:1
Straw (Bulking Agent)	1.0	0.1	50:1 to 300:1
Water *			

*A mixture that has enough moisture (50-65 percent) to feel moist to the touch but not so moist that water can be wrung out should be about right, i.e. it should feel like a "damp sponge" to the touch.

Final Disposition of Compost

Compost produced from animal carcasses or animal body parts may only be distributed to the public if the operation has temperature records to show that the batch under consideration has met the time/temperature standards for the specific composting system being used .(See section 'Meeting Time/Temperature Standards' for a list of these standards.)

Compost that has not met the appropriate time/temperature standard or for which there is no record indicating that it has met the standard may be spread on the owner's own fields. It may also be incorporated into other batches of compost and re-composted in order to meet the time/temperature standard.

Compost that has met the standards may be used for any purpose for which it is suitable based on its agronomic characteristics.

Management of Bones

In most compost piles, the soft tissue from the carcass will disappear much more quickly than the larger bones. This means that the operator must be prepared to manage the bones in the finished product. This can be done by one of the following methods:

1. Grinding the bones/compost mix so that the bone particles become a part of the final product.

2. Screening out the bones from the final product. The separated bones may be buried, added to another active compost pile and re-composted, ground up for use as a calcium-rich soil amendment or even burned.

3. Spread compost including bones on land. The compost product with bones may be spread on forest land or agricultural fields. Consideration should be given to possible impact of large bones on equipment that may be operated on the field in the near future. Experience has shown that if compost with bones is spread on tilled ground, the tillage equipment will break up the bones and incorporate them into the soil. Spreading bones on hay ground, on the other hand, may be undesirable since they can be picked up by the haying equipment.

Monitoring

Visual Inspection. Carcass compost piles should be visually inspected daily for the first week after construction and then at least once a week for the next 10 to 12 weeks. It is important to make sure that any maintenance needed is recognized quickly and taken care of promptly.

Temperatures. If distribution of the final product to the public is being contemplated, then temperatures must be taken and recorded daily (at least 5 days per week) until the time/ temperature standard has been met. (The procedures for taking temperatures are given in the section on taking temperatures on page 10. To be meaningful, temperatures should be taken in the same locations each time. Marking the locations for temperatures with a stake, flag or other marker helps make temperature taking more consistent. Graphing pile temperatures is a good way to visualize how the pile is performing over time and may help in making management decisions in the future. If carcasses are being added to the end of an existing windrow and the time is more than 2 weeks between successive additions, there should be a gap left and treat the continuation as a new windrow for the purpose of taking temperatures and management activities.

Moisture. .Moisture can be checked using a squeeze test The compost medium should be damp to the touch when a small amount is squeezed by hand but not so wet that water drips out

Record Keeping

Record keeping is important in composting as in all other farm activities. Here are some records that should be maintained:

Location and Date piles built. It is important, especially if the compost is to be distributed to the public, that each batch be identified uniquely. This unique identification, should include the pile location on the site and the start date. The date when the last addition of raw ingredient is made is usually recorded as the start date. It is from that date, that the time/temperature requirements are tracked.

Temperatures. (See sample temperature chart in Appendix.) Temperature records must be maintained if the compost product is to be distributed to the public. Even if the product is to be used on the farm fields, the temperature records are a useful tool in evaluating the compost process.

Disposition of Compost. If the farm operation is required to have a nutrient management plan under Maine law (7 MRSA §4201 – §4209), the farm must maintain a record of the disposition of all nutrients, including compost, that were generated on the farm or brought on to the farm. Even if a nutrient management plan is not required, there should be a record of the final disposition of each batch, whether it is distributed to the public or used on the farm's own fields.

Emergency Disposal Situations. Chapter 211 requires that for emergency carcass disposal situations, the following records shall be kept for **at least one year after the compost product has been distributed**: Location and date piles built, Temperatures measured in the compost piles, record of the disposition of the compost.

Biosecurity

For Livestock operations, biosecurity has become an important consideration. The threat of the spread of highly contagious diseases is ever present. A compost operation on a farm should adhere to biosecurity measures just as other farm operations do. (See the references for useful publications on farm biosecurity measures.) Here are some biosecurity considerations:

Good pile construction and maintenance. For routine mortality, one of the most important biosecurity measures is taking care to build the compost pile correctly to discourage disease vectors (scavengers) from disturbing the pile. Likewise, prompt maintenance when cracks appear or part of a carcass is exposed is a must. Take care not to use the same equipment for the raw inputs and finished product unless it has been cleaned after handling raw materials.

Large scale disaster . In cases of where a large number of carcasses must be managed quickly, it may be necessary to bring additional equipment, personnel or materials onto the farm to handle the larger volume. Biosecurity protocols should be established to minimize the amount of traffic on and off the farm, to ensure proper disinfection procedures are used and to limit exposure of livestock to off-farm traffic.

Disease outbreak. – In the case of a disease outbreak, the farm operation should contact their veterinarian as soon as possible to assess the disease. If the veterinarian suspects that it is a reportable disease, he or she will then notify the appropriate state and federal animal health authorities for direction on implementing biosecurity measures.

Small Backyard Poultry Flocks

Most of the systems or approaches described in this document are intended for use by commercial agricultural operations. Small flock owners should refer to University of Maine Cooperative Extension. bulletin: "Safe Disposal of Backyard Poultry Mortalities". (2006) for guidance in disposing of a small number of birds in an emergency.

DIAGRAM 1.

DIMENSIONS OF COMPOST WINDROWS FOR DAIRY COWS.

Assumptions:

1. There will be **two feet of cover material beyond the carcass** on the ends and sides of the windrow.

2. There will be **18 inches of material below and two feet +/- of material over** the carcass. (more in winter)

3. The back of one carcass may rest on the legs of the adjacent carcass.

4. Volume of base material needed is determined by the formula:

   Vol. = 1.75X + 1.75 where X is the number of cows being composted.

   Example: for **four cows**,
   Vol. = 1.75 x 4 + 1.75 = **8.75 cu. yds**.

5. Volume of cover material needed will be determined by formula:

   Vol. = 6X + 6. where X is the number of cows being composted.

   Example: for **four cows**,
   Vol. = 6 x 4 + 6 = **30 cu. yds**.

6. Windrow length may be determined by formula:
   Length = 4 x X + 4. where X is the number of cows being composted.

   Example: for **four cows**
   Length = 4 x 4 + 4 = **20 ft.**

7. Use pairs of windrows to save space on pad.

8. Windrows run up/down slope with slope about 2-4%

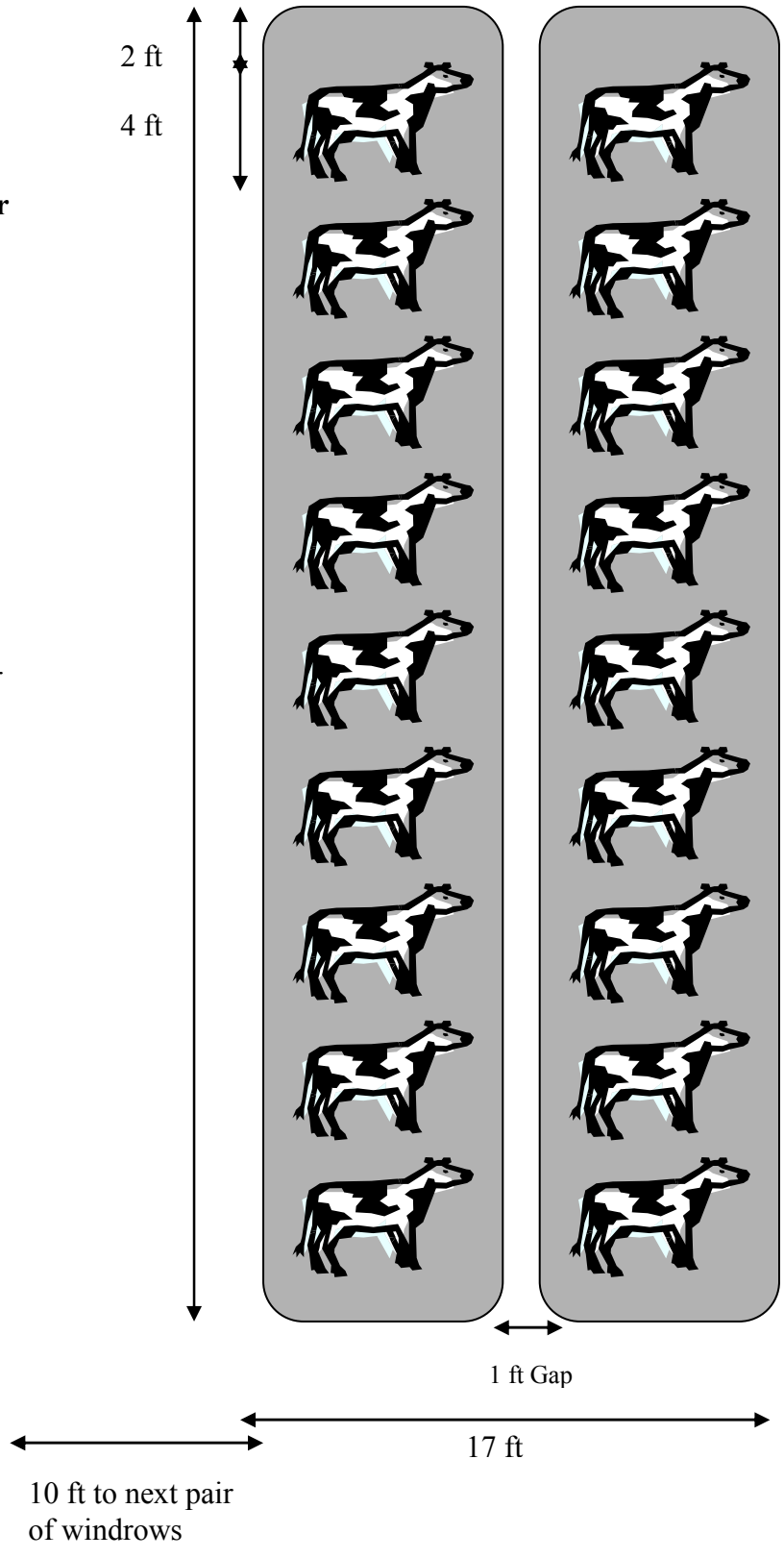


DIAGRAM 2.

COMPOST WINDROW LAYOUT FOR LARGE ANIMAL CARCASSES

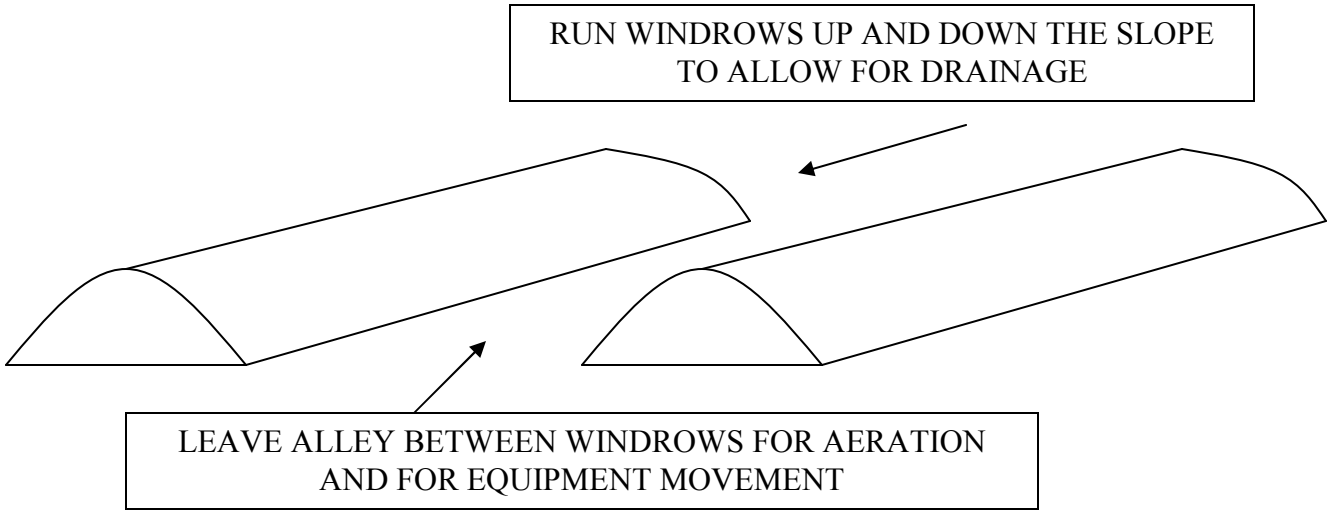


DIAGRAM 3.

WINDROW CROSS SECTION FOR LARGE CARCASSES

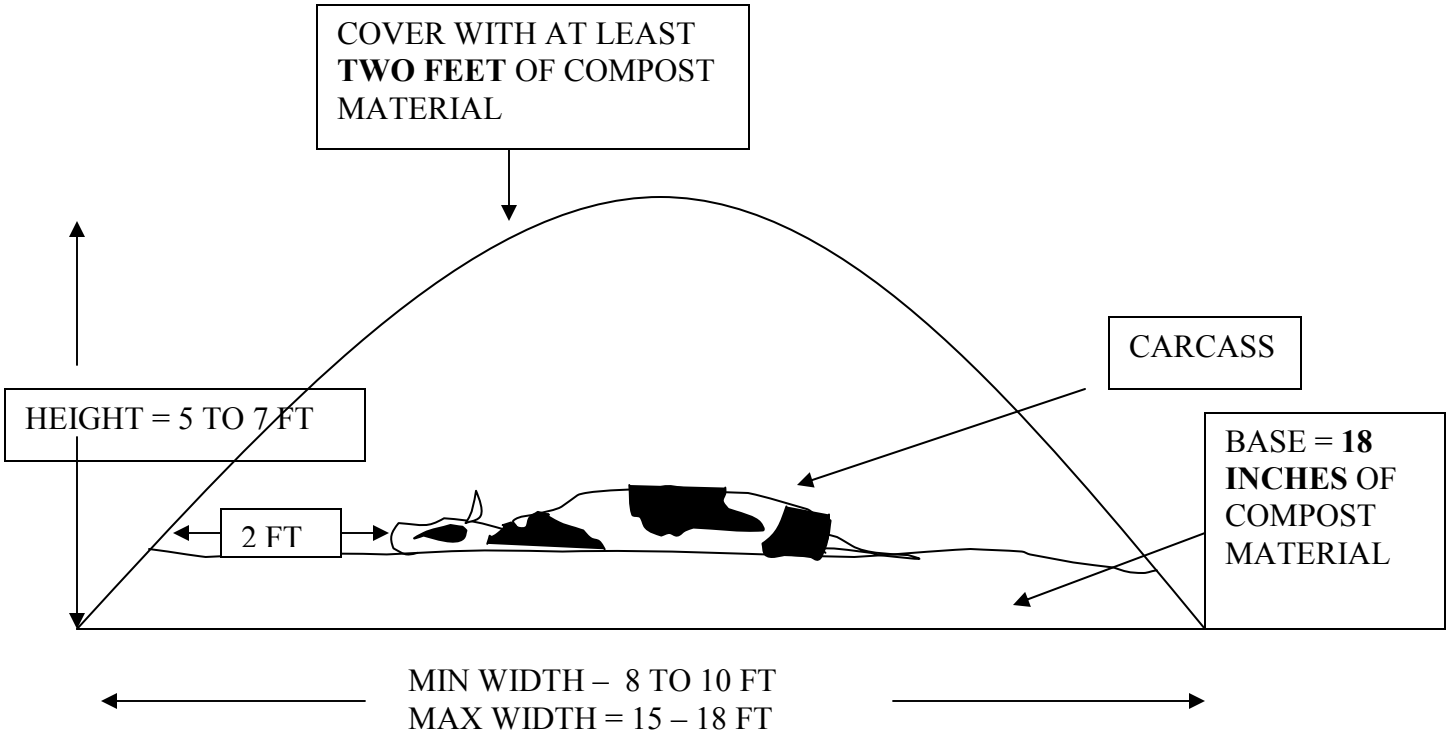
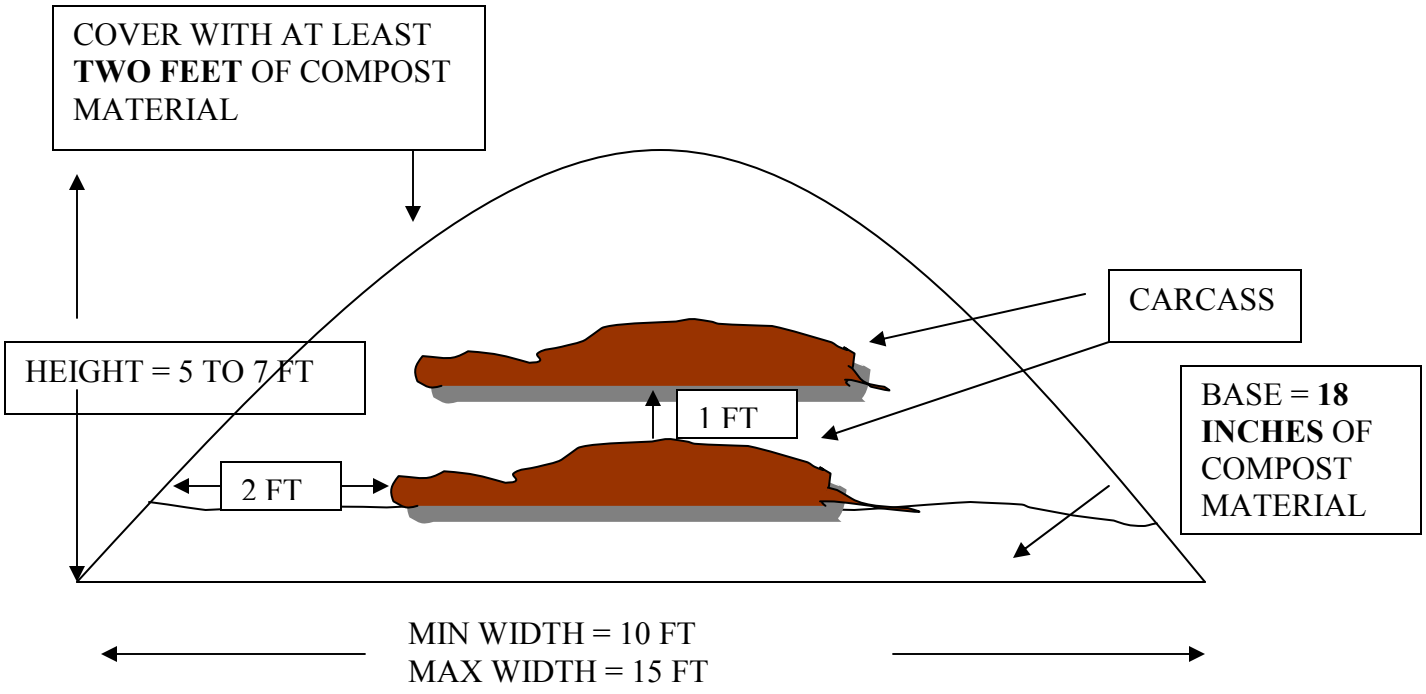
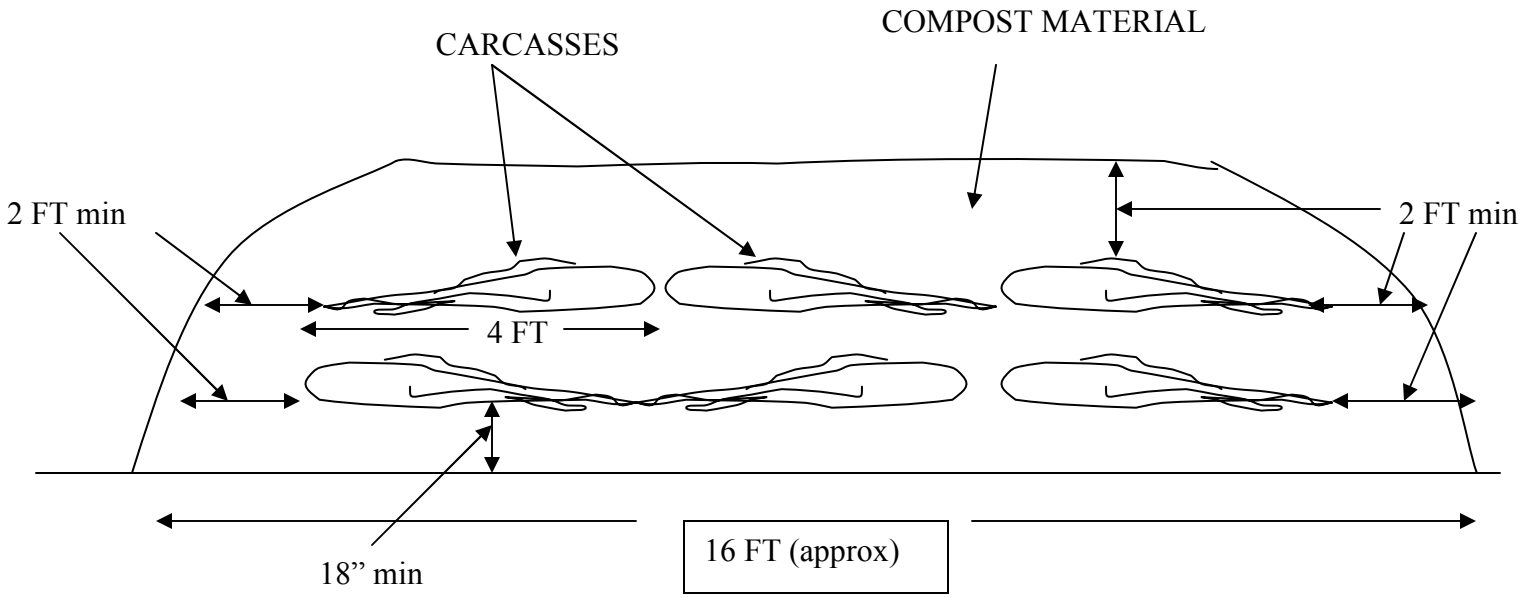


DIAGRAM 4

WINDROW CONSTRUCTION for MEDIUM SIZE CARCASSES



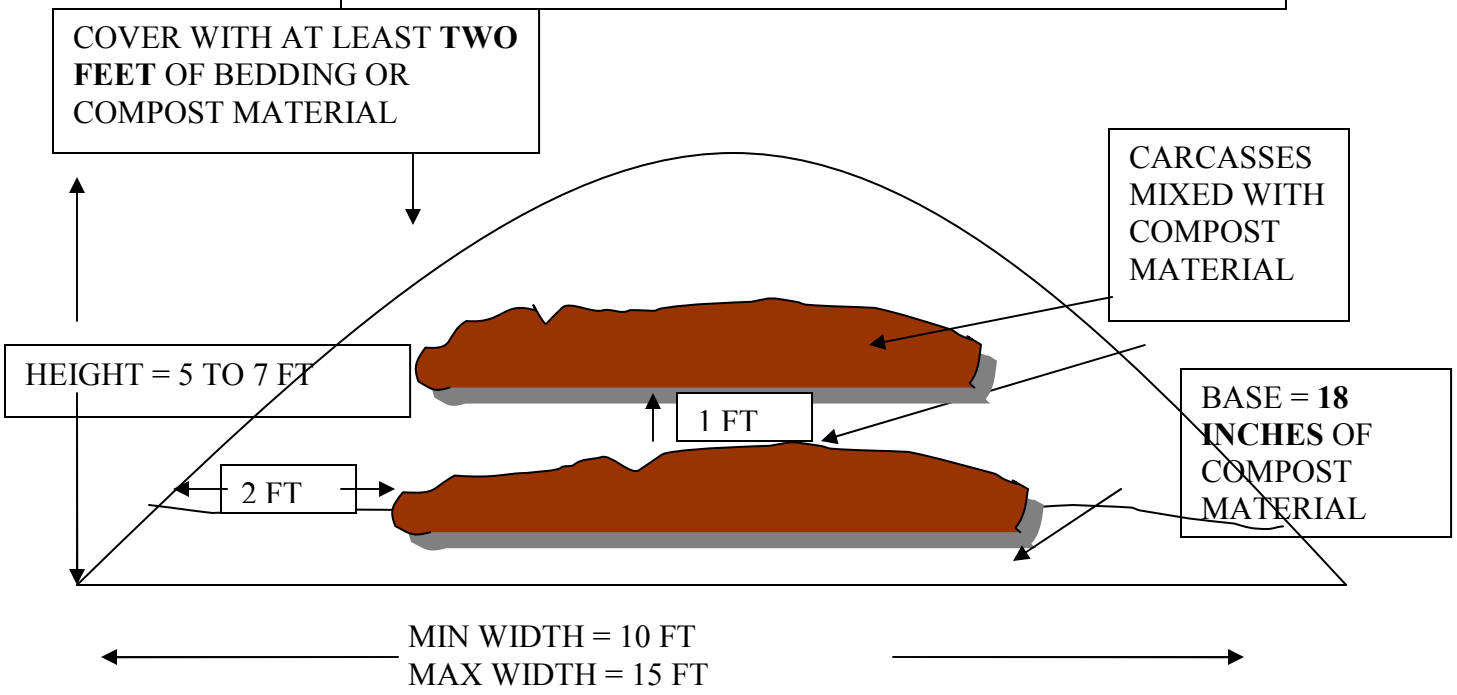
WINDROW CROSS SECTION: END VIEW



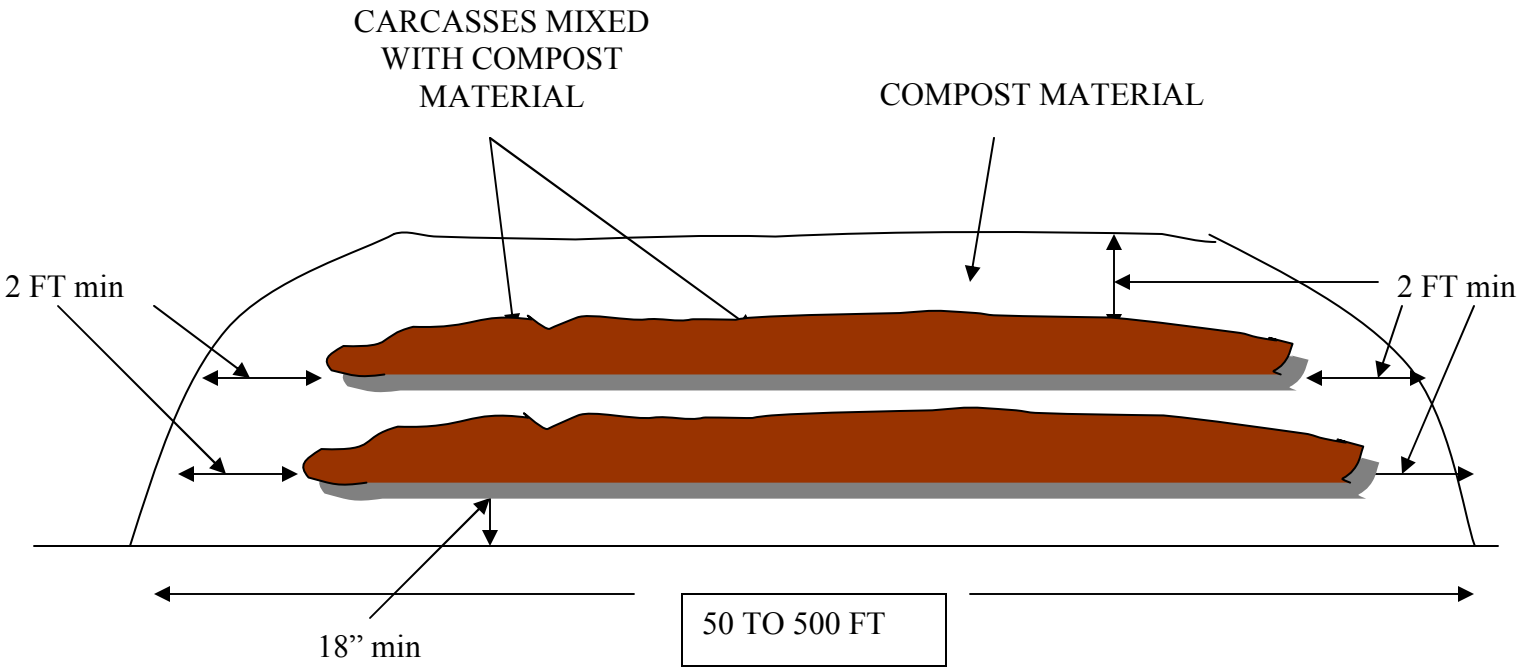
WINDROW CROSS SECTION: SIDE VIEW

DIAGRAM 5

WINDROW CONSTRUCTION for POULTRY AND OTHER SMALL CARCASSES



WINDROW CROSS SECTION: END VIEW



WINDROW CROSS SECTION: SIDE VIEW

DIAGRAM 6	WINDROW CONSTRUCTION for OFFAL

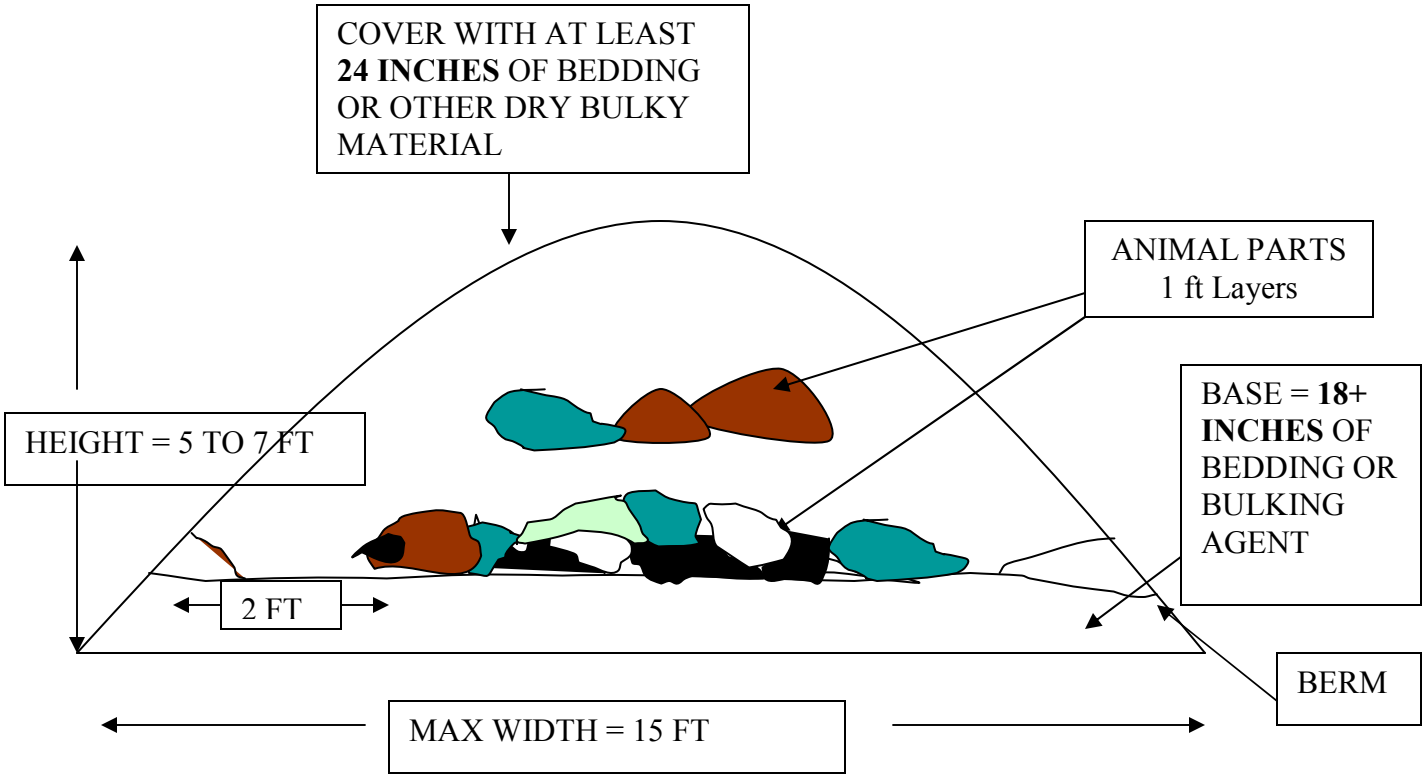


DIAGRAM 7. LAYERING FOR A TURNED WINDROW PRIOR TO TURNING

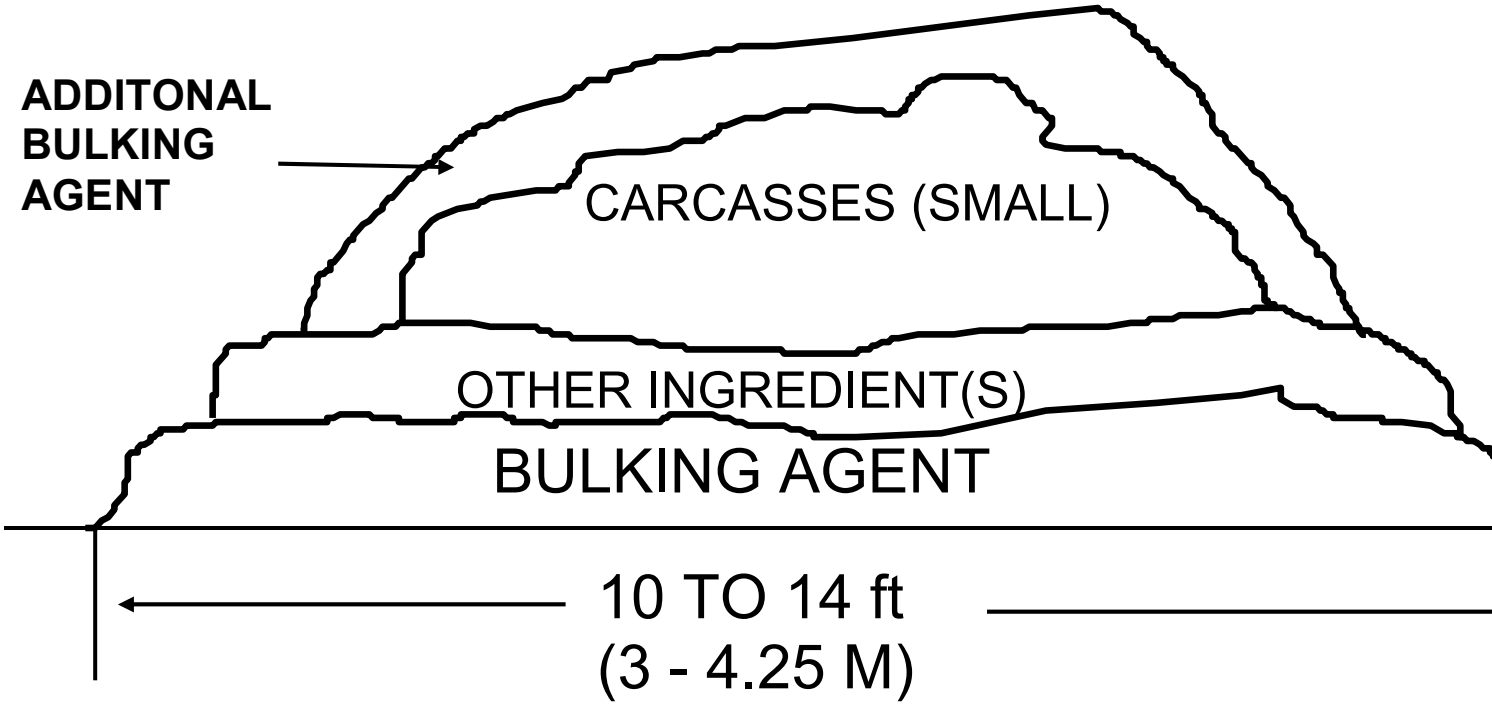


DIAGRAM 8 LAYOUT FOR AN AERATED STATIC PILE

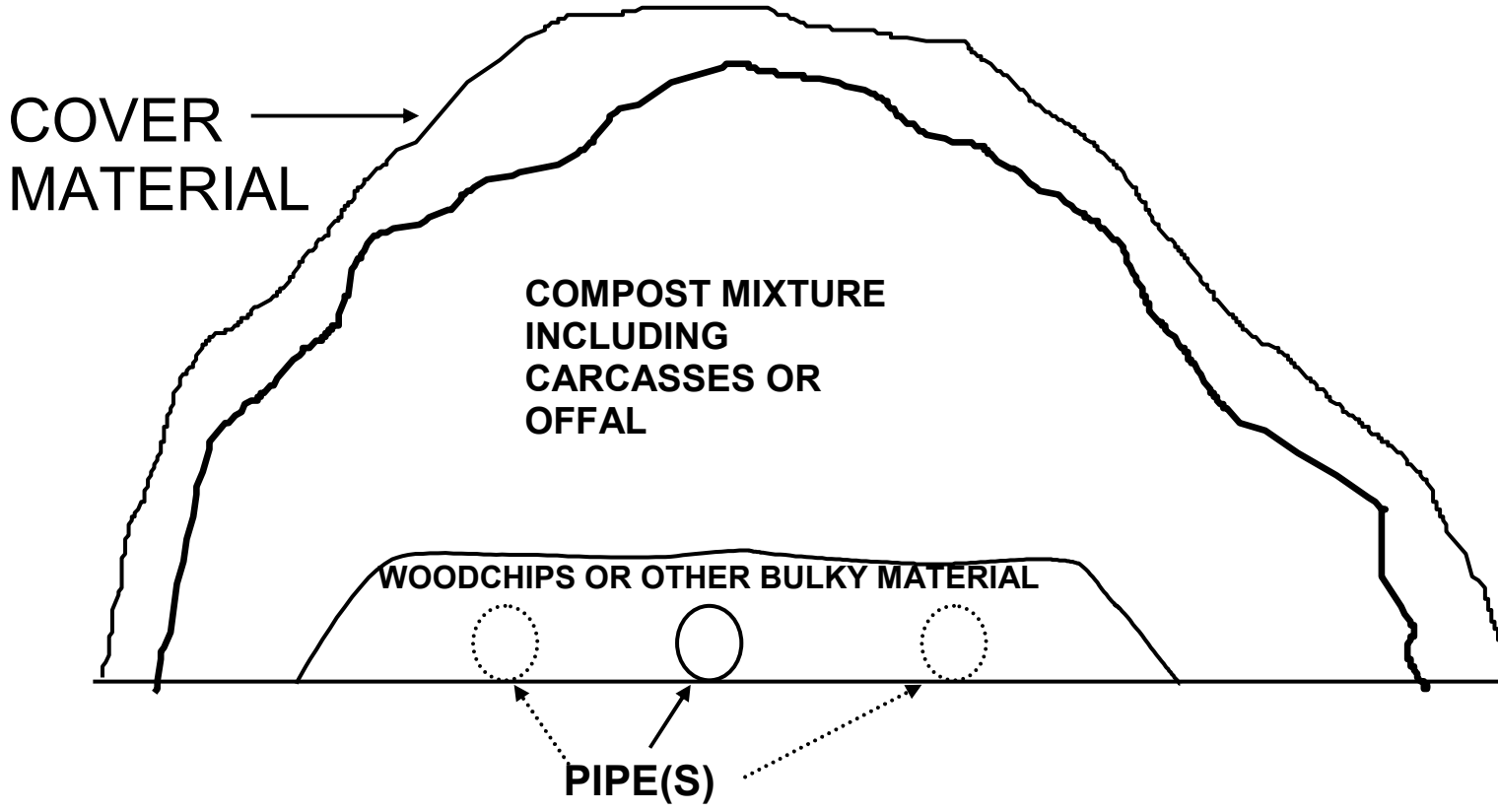
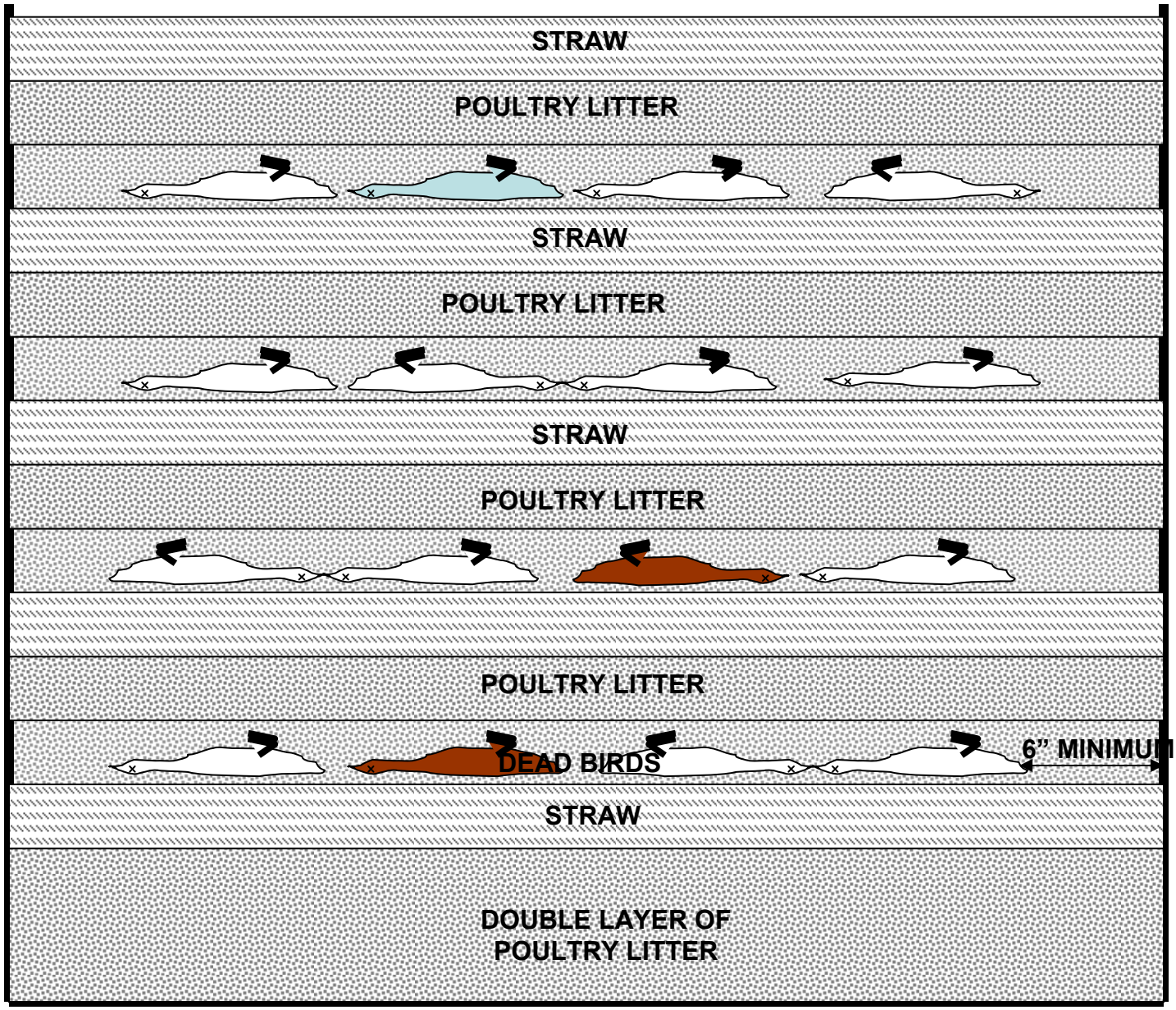


DIAGRAM 9 .LAYERING IN THE MARYLAND BIN COMPOST SYSTEM



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CARCASS COMPOST TEMPERATURE RECORDS

LOCATION ___________ PILE CONTENTS _________________________ STARTING DATE___________

DATE	TIME	One Foot	Three Feet	Internal	Animal Activity Signs	AIR TEMP	WEATHER	PILE MGT./Comments