Carcass Management Course
Composting Module

USDA United States Department of Agriculture

CUBIC
Enabling a Safer World

Table of Contents

Overview

Welcome to the Composting Module of the online Carcass Management Course. While completing this module, you may encounter references to the Emergency Management Tools; Health, Safety, and Personal Protective Equipment; Secure Transport; and to Biosecurity, which are broadly covered in their own separate training modules. These modules are found in the Introduction Modules, beginning with the Orientation Module.

> This training module is presented from the perspective that you have already used the MLCh Tool (Matrix, Decision Loop, and Checklist) explained in the Emergency Management Tools Module and selected composting as the preferred carcass management option.

Effective management of carcasses and associated materials is a critical component of a successful response during an animal health emergency. Carcass management measures contain, treat, or destroy contaminated or potentially contaminated materials in order to:

- Prevent spread of a disease outbreak to protect the nation's agricultural industry
- Protect the environment by preventing carcass waste products from contaminating soil, water, and air
- Protect decaying carcasses from insects and scavengers which can transport pathogens to other locations
- Safeguard public health by removing potentially contaminated food products from the human food supply
- Safeguard animal health by removing potentially contaminated feed from the animal feed supply

Objectives

This module presents the material in four different lessons:

- Introduction
- Evaluation
- Planning
- Operations

Upon completing this module, you should be able to:

- Describe composting as a method for carcass management
- Understand the advantages and disadvantages of composting
- Consider environmental risks associated with composting
- Obtain regulations governing composting by consulting with state officials
- Identify factors used to evaluate composting as a carcass management option
- Recognize key components of composting operations

Introduction Lesson Overview

Definition: Composting is a natural biological carcass management method that promotes biomass decomposition through mixing or layering carcasses with carbon rich organic materials. The decomposition process requires nitrogen, carbon, oxygen, and moisture for optimal tissue breakdown. The heat generated during this decomposition is sufficient to inactivate many pathogens.

The general process of composting is as follows:

- Composting is an aerobic (oxygen present) process, that is typically only reached under intensively managed conditions
- In general, carcasses have a high nitrogen content and the addition of organic plant material (referred to as carbon material, co-compost or bulking agent) provides the necessary carbon to provide the conditions for organic composting to occur
- The carbon material absorbs excess moisture and insulates the compost pile to maintain the high internal temperatures necessary for rapid decomposition and pathogen inactivation
- Composting may be carried out either indoors or outdoors

Introduction Lesson Contents

This lesson is divided into the following sections:

- Description - Presents the key features of a compost pile
- Types - Contains information on the three basic types of composting approaches
- Design Characteristics - Discusses the basic design and components of windrow composting, bin composting, and bag composting
- Advantages - Describes the benefits of using composting as a carcass management option, both in house and outdoors
- Disadvantages – Covers the difficulties and possible drawbacks associated with composting animal mortalities

Description

Carcass composting is a process that involves constructing a porous base layer of carbon material, mixing or layering carcasses with carbon material for the core of the windrow, and capping the mixture with a blanket of carbon material to promote decomposition of carcasses at elevated temperatures. Carcass composting consists of two phases: an active phase and a curing phase. Emergency responders will likely only participate in the active phase when pathogens are inactivated.

The active phase is characterized by aerobic reactions at relatively high temperatures resulting in a large reduction in the volume of biodegradable solids.

- This phase has the potential to produce significant odors which can be controlled using a carbon material cover over the compost pile
- Core pile temperature should rise to 135-140°F (57-60°C) within 15 days and then be maintained for several days. Intervention, such as turning the pile, may be required to maintain the desired temperatures. For intact large-animal carcasses, elevated-temperature aerobic conditions should be maintained for weeks.
- During the composting process, mesophilic and thermophilic species of bacteria and fungi are active and destroy many pathogens
- For inactivating avian influenza, USDA requires a temperature of 131°F (55ºC) be maintained for 72 consecutive hours during both of two 14-day phases separated by turning the piles

In the curing phase, which is generally not part of emergency response, but may occur later, aeration is not as critical. During this period, a series of slow-rate reactions, such as the breakdown of lignin, occur at temperatures below 105°F (41°C).

- At the end of the curing phase, internal temperatures within the compost pile range from 77-86°F (25-30°C)
- The material bulk density is reduced by 25 percent and the finished product appears dark brown to black and is free of unpleasant odors

Description (cont.)

Carcasses can be composted whole or, to speed the process, can be ground and mixed with carbon material (e.g., sawdust, wood chips, ground cornstalks, and ground straw, to name a few).

- Care must be taken to prevent dispersion of pathogen-laden aerosols during grinding and mixing, if the carcasses are infected. For example, if air-borne spread is a concern, the grinding process can be contained, and mixing can include dust control measures to mitigate the concern
- To increase decomposition speed, carcasses that are composted in their entirety may need to be mechanically turned at least three times during composting to promote aeration, increase temperatures and facilitate further decomposition. Note: decomposition is a temperature dependent process.
- Infected carcasses should be turned only minimally, if at all, to avoid dispersing pathogens
- For poultry composting, turning the pile can speed decomposition; however, if the pile is constructed correctly, turning is not necessary and is not recommended within the first 14 days for infected carcasses
- Larger animals may not be turned before 30 days

Figure 1. In-house windrow

Types

Windrow composting involves constructing trapezoidal shaped compost piles in long uncovered rows.

- The carcass material is placed on a thick layer of carbon material (a minimum of 10 inches thick, as much as 2 feet for large animals) then capped with a blanket of carbon material at least 8 inches to a foot thick
- The windrow piles are mounded in order to shed rainfall and to better control moisture, temperature, gases, and odors
- The 8-12 inch thick cover serves to protect against predators, reduce attraction of insects, and minimize odors
- Clean sawdust is one example of a suitable cover material

Figure 2. Windrow Compost

Types (cont.)

Bin composting is the natural decomposition of dead animals in a contained system.

- Carcasses are placed within a mound of carbon material contained in a walled structure
- The system may be built of any material that is structurally adequate to confine the compost pile material. The structure may or may not be covered by a roof.

Figure 3. Bin Compost

Design Characteristics

Windrows should meet the following criteria:

- Are usually 6-8 feet high and 12-15 feet wide and constructed on a uniform base layer (10-15 inches thick) of a sufficiently porous and absorbent carbon material
- Have one layer of large animal (e.g. bovine) carcasses but smaller animal carcasses (e.g. poultry, swine) can be layered or mixed with carbon material
- Carbon to Nitrogen (C:N) ratio of 30:1; moisture content at 40-60%; varying sizes of carbon material from 2 inch to very fine material; tissue density at 15:1
- Windrows should be placed 10-20 feet apart for worker and equipment access
- The base layer and windrow are not compacted with equipment
- Good carcass to carbon contact is ensured by creating a core with a minimum 1:1 mix, by volume, of carcasses, carbon, and other infected material
- Should be constructed to ensure adequate distribution of moisture throughout
- Are capped with carbon material (8-12 inches) to ensure that no carcasses are exposed and to minimize odor. Slope the sides of the pile.
- Dimensions, including the base and cap, may be reduced for smaller carcasses

Computerized Estimator

Use the Spartan Emergency Animal Tissue Composting Planner to estimate the total amount of amendment needed. Then, use the Spartan Compost Recipe Optimizer v1.04 to estimate the amounts/proportions of amendments needed; given the availability of amendments (poultry manure, poultry litter, sawdust, bark, etc.).

The tool is an Excel Spreadsheet which calculates the amount of animal mortality on a premises or in a response event, and calculates the amount of carbon material which would be needed to compost that amount. It also provides information on windrow size, volume and foot print.

Advantages

Composting has a number of advantages, including:

- On-site composting reduces the need for off-site transportation
- Compost can serve as a nutrient rich product that can be applied to land to improve soil texture and increase crop productivity
- Many producers already use composting for managing routine mortalities and are familiar with composting procedures, although procedures for composting routine mortalities may differ significantly from emergency mortality composting
- When done correctly, composting is a biosecure method. It will inactivate the foot-and-mouth disease virus, avian influenza virus, and many other viruses in 10-14 days when internal compost pile temperatures reach or exceed 133°F (56°C).
- Composting reduces the risk of groundwater contamination, air pollution and farm-to-farm disease transmission when performed properly (e.g., under the guidance of a Composting Subject Matter Expert (SME))
- Composting creates a useful byproduct that is easy to handle and can be stored for long periods
- Outdoor windrow composting can be adapted for a large number of dead animals. This method is feasible for any size of animal, and the length of a windrow can be increased to accommodate additional carcasses, limited only by the amount of available space and availability of suitable carbon material.

NOTE

In an emergency response where APHIS is the lead federal agency, a Composting SME may be assigned by USDA APHIS to ensure the key elements are followed in the construction of compost windrows. Additionally, the APHIS-assigned SME may evaluate the windrows and recommend corrective actions, if necessary.

Disadvantages

Potential disadvantages of outdoor composting of large animal carcasses include:

- Additional carbon material may need to be brought in from offsite which increases traffic and may increase risk of disease spread
- Additional water may be needed
- Requires more on-going management and labor than other methods
- Because outdoor windrow compost piles are built in unprotected open spaces, they are exposed to more adverse weather conditions than are other methods such as indoor or roof-covered bin composting.
- Disease agents such as those causing bovine spongiform encephalopathy and some pathogenic spore bacteria may not be completely inactivated by pile temperature

Evaluation Lesson Overview

This lesson contains information to help you further evaluate use of composting as a carcass management option. During an animal health emergency or other event resulting in catastrophic animal loss, composting offers many advantages because a relatively large quantity of carcass material can be processed.

Factors in the evaluation include:

- Knowing and understanding applicable regulations
- Evaluating the waste stream
- Evaluating the composting site
- Assessing availability of required resources including mortality composting experts and suitable carbon material
- Recognizing the environmental impact

Evaluation Lesson Contents

This lesson presents the following information:

- Regulations – Covers the regulations governing composting operations
- Evaluating the Waste Stream – Contains questions one can use to assess the materials on the infected premises to determine suitable management options
- Composting Site Evaluation – Presents information including questions to assess whether or not a site is suitable for carcass composting
- Environmental Impact – Includes a discussion of potential environmental impacts, important biosecurity considerations, and public health considerations associated with composting

Regulations

Regulations that address composting vary by state. Consult with state and local environmental agencies to obtain the most current regulations, prior to undertaking a large-scale composting operation.

The Gateway to State Resource Locations provides access to a variety of state resource locator tools, including state environmental regulations.

All waste materials slated for carcass management and/or transport must be correctly classified by an experienced waste manager prior to carcass management. Below are some of the considerations for classifying and transporting waste:

- Solid waste - Most animal related waste generated during a response to an animal health incident will be classified as solid waste for management purposes
- Medical and infectious (solid) waste - A portion of the waste material associated with a response to an animal health emergency may be classified as medical and/or infectious waste, such as used sharps or needles, and will be subject to state regulations
- Hazardous materials - If carcasses are moved under US Department of Transportation authority, infectious waste (including carcasses, bedding, etc. which can cause disease or death in animals or humans) is classified as hazardous material unless a special classification is obtained. Hazardous material will require special packaging, manifesting, and transport to an appropriate facility approved to accept the materials.

- Permitted Movement – When infected carcasses are permitted to move under APHIS/state authority, they will require DOT designation as hazardous material
    - In compliance with 49 CFR 105.5 and 49 CFR 173.134, as well as, other related 49 CFR requirements, and
    - In compliance with incident-specific state and federal requirements for biosecurity, transport method, chain of custody, and cleaning/disinfection (e.g., using VS Form 1-27)
    - Refer to the NAHEMS Guidelines: Quarantine and Movement Control for additional information

Regulations (cont.)

The EPA has delegated authority to most states for solid waste disposal under RCRA, which may include composting programs. For those states without delegated RCRA authority, the US EPA may oversee implementation.

The requirements for permitting composting operations may vary among states. On-farm and centralized composting during an animal health emergency will require approval and guidance from state and possibly federal environmental authorities.

Additionally, 40 CFR Part 503 under the Clean Water Act (CWA) pertains to land application (and bio solids composting), surface disposal, and combustion of bio-solids (sewage sludge). Many of the standards promulgated in this rule can be applicable to animal mortality compost.

Waste Stream Evaluation

The following are issues one should consider before starting composting activities:

- What types of infected material?
    - Carcass: type, size, number and condition
    - In-barn manure/litter: type, volume, moisture content, density
    - Stored manure/litter: type, volume, moisture content, density
    - Feed? Quantity, location, physical characteristics (i.e., mash, hay)
    - Eggs? Quantity and condition
    - Bedding? Non-infected manure compost?
    - Paper products? Other debris?

- How much material needs to be composted?
    - If there is more material than on-site composting can handle, off-site carcass management may be required
    - The material from a large outbreak may have to be sent to multiple off-site locations as capacities are reached

Composting Site Evaluation

Are site conditions suitable for outdoor composting of the amount of biomass affected? Emergency poultry mortality compost sites should be large enough to accommodate all of the generated carcasses, litter, waste feed, and other contaminated materials, as well as have the ability to store any additional amendment materials that may be needed for successful composting.

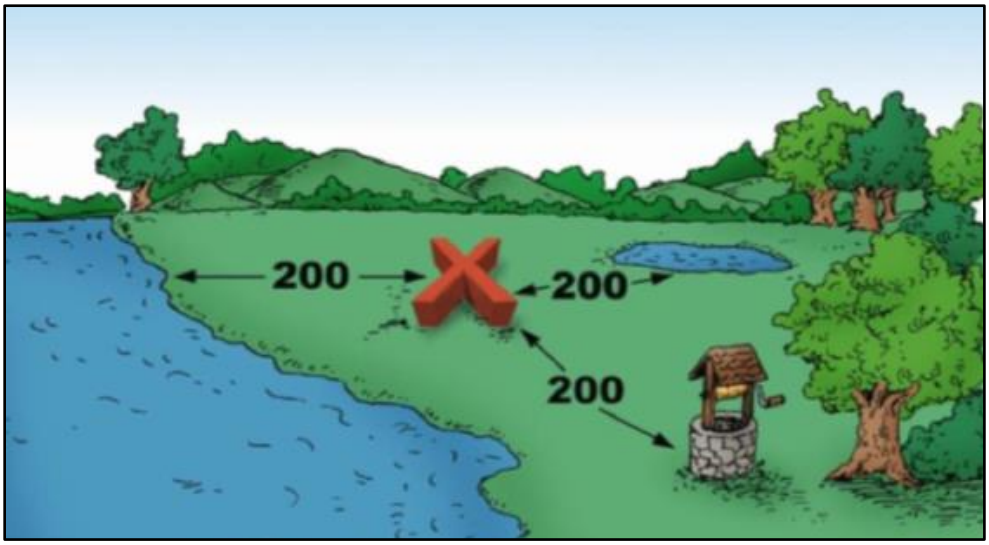
Ideal compost sites should:

- Be located such that the prevailing wind directions do not travel to nearby residences
- Be located at the top of the slope of the field, on moderately to well drained soils,
- Have a gentle slope to encourage on-site drainage
- Be at least 24 inches above seasonal high water tables
- Be at least 36 inches above bedrock
- Not be located on a flood plain

Composting Site Evaluation (cont.)

- Be constructed with surface water management features, such as diversion ditches, terraces, or berms to direct surface water flows and storm water away from active compost piles
- If piles are located between production houses, then roof drainage should be directed away from the compost area
- For all outdoor compost piles/windrows, surface drainage should be directed away from the compost area, and the edges of the identified site should follow state-specific minimum setbacks, such as those outlined below by Cornell University:
    - 200 feet from a water supply well used for drinking;
    - 200 feet from water bodies, including: ponds, lakes, streams, rivers;
    - 200 feet from a nearby residence (not owned by the premises);
    - 50 feet from a drainage swale that leads to a water body; and
    - 25 feet from a drainage swale that does not lead to a water body

Figure 4. Minimum Setback Distances



Composting Site Evaluation (cont.)

Composting large-animal species such as beef and dairy cattle often occurs outdoors. Site selection for outdoor composting is critical and the state should be consulted. If the response involves USDA APHIS, APHIS may also provide a composting expert to assist.

Another consideration is the local availability of large quantities of carbon materials-both as a cover material and as a thick base layer. For every pound of carcass weight, up to three pounds of carbon material is required.

Figure 5. Types of Carbon Material

Composting Evaluation Questions

Crisis management and farm officials should conduct a survey of potential composting sites and their overall suitability. Technical expertise will be required for large composting operations at multiple sites both during pile construction and during the extended composting process.

- Does the composting plan meet federal, state, or local regulatory compliance and does it prevent environmental contamination?
- Has explicit permission to begin composting been granted by authorized approving agencies?
- Are on-farm land areas limited? Will the large number of animal mortalities from an animal disease outbreak limit the composting option?
- Will selection of composting be made jointly by farm owners and the members of an incident command structure (ICS) comprised of state or local authorities?
- Is there an existing memorandum of understanding allowing carcass transportation to the county with the nearest composting land areas?
- Has the ICS considered the transportation challenges?

Many states have orders of priority for carcass management options. The ICS must be aware of these and plan to execute carcass management actions, based on these priorities.

Environmental Impact

When outdoor composting is conducted at a proper site, the risk of environmental contamination is low. Indoor composting provides a controlled environment that reduces the need to move contaminated material and also has a low risk of environmental impact. The temperature achieved during properly managed composting will kill many pathogens reducing the chance to spread disease.

- By using a 1-2 foot base of carbon material (thickness of base depends on the species; see specific avian and large animal composting protocols discussed later in this module), leachate from the compost windrow is limited to the first few feet of soil under the windrow, according to research published by Iowa State University.
- Ammonia concentrations beneath compost windrows increase 40-160 times but are limited to the top 6 inches (15 cm) of soil. No statistically significant increases in ammonia are found below 35 inches (90 cm).
- In regions with higher precipitation, both capping the windrow with 1-2 feet of carbon material and routine monitoring will prevent nitrogen release

Figure 6. Composting Potential Risks (Click to Enlarge Image)

Environmental Impact Questions

- Is the compost windrow constructed in accordance with the approved APHIS protocol for the response?
- Is windrow temperature monitoring performed daily?
    - Logs maintained?
    - SME consulted if temperature averages are below or above established levels or standards?
- Do Phase 1 and Phase 2 windrow evaluations indicate correct compost pile construction?
    - Correct height and width?
    - No soft tissue visible?
    - Adequate moisture? Leachate present?
    - Vector activity? Odor?
- Does record keeping meet the regulatory requirements?
- Who will keep the records?
    - This is important to identify who may be legally liable, in case there is an environmental release in the future

Biosecurity

Biosecurity is a series of management practices designed to prevent the introduction and spread of disease agents on an animal production facility. During an animal disease emergency, biosecurity measures are necessary to keep disease agents out of healthy livestock and poultry populations and prevent the spread of disease agents from infected groups to uninfected groups within the same population.

Below are some biosecurity considerations that apply to composting. For more comprehensive biosecurity information, refer to the Biosecurity Module.

- Plans must be in place to prevent disease spread during transportation. For more information see the Secure Transport Module.
- Workers who handle infectious carcasses need to take proper precautions and should be equipped with appropriate PPE in accordance with site-specific plans. Refer to the Health, Safety, & PPE Module.
- In cooperation with appropriate public health agencies, personnel should be monitored afterward for signs of illness if pathogen of interest is potentially zoonotic

NOTE

The agent causing the disease may not be the only agent that poses a risk to personnel. Other potential risks may occur from *Salmonella, Campylobacter*, Q fever and coliforms.

- Proper storage for carcasses should prevent scavenging by wildlife and access by other vectors
- Prior to the selection of composting as an option, verify that it has been shown to inactivate the disease agent of interest

Biosecurity (cont.)

- Proper long-term temperature and moisture management is required to ensure disease agent inactivation. Core temperatures of 135-140° F are typically required for 3-12 week duration to insure inactivation of disease agents.
- Large carcass management operations require the transportation to the site of significant amounts of carbon material. Adequate cleaning and disinfection of transport equipment is required in order to contain disease spread.
- Mechanical turning or mixing of compost piles may promote biomass degradation; however, in the case of infected carcasses, it may increase the risk of spreading the infectious agent.
- When constructing a compost windrow, infected carcasses and other biomass should preferentially be placed near the center of the pile where temperatures will be the greatest.

Some bacterial species may regrow as the composting pile temperature decreases.

Public Health Considerations

A comprehensive understanding of the type and strain of pathogen associated with the animal disease event is essential to prevent further spread of infection and to safeguard human, animal, and environmental safety and security. Biosecurity measures along with cleaning and disinfection protocols will be governed by the type and strain of pathogen present.

- Negative public perceptions may be an issue in the event of large-scale on-site composting. Care must be taken to conduct composting operations in such a manner that public impact is minimized.
- Off-site composting or other management options will also require transportation of potentially contaminated biomass that may have additional public perception implications
- Heightened public health concerns will exist and must be addressed when dealing with a zoonotic disease agent

Public Health Questions

The following questions will help evaluate the public health concerns associated with composting activities:

- Are there event and site-specific health and safety plans for the composting operators that are approved by a credentialed Safety Officer?
- Are composting operators trained in proper handling of potentially infectious material and the requirements of the health and safety plan? If not, will specialized operators be available for temporary service at the composting site?
- Is employee health and safety monitored and are health and safety rules enforced? If the contaminant poses an increased health risk to employees, it is important that personnel use required protection and are monitored regularly by healthcare workers to ensure they are not exhibiting effects of exposure.

Planning Lesson Overview

This lesson contains information to help you plan for composting of carcasses resulting from an animal health emergency. Planning is essential to ensure that the task is carried out efficiently and unimpeded by a lack of resources. Successful management of a large number of contaminated animal carcasses requires proper planning to protect workers, the general public, susceptible animals, and the environment.

Important considerations include:

- Classifying and characterizing the waste material
- Identifying suitable composting sites
- Finding adequate carcass storage facilities
- Assessing availability of secure transportation

Planning Lesson Contents

This material in this lesson is divided into the following key sections:

- Personnel – Highlights requirements and related issues associated with personnel involved with the carcass management activities
- Waste Classification – Discusses the procedures necessary to clearly identify and describe the material being disposed
- Materials, Supplies, and Equipment – Provides a list of equipment and supplies which might be needed for composting, including a list of carbon materials for windrow construction
- Secure Transportation – Provides a list of important questions to consider before transporting carcasses
- Site Suitability – Describes planning considerations for selecting suitable composting sites

Personnel

There are certain planning aspects that are common to all carcass management options. Those aspects include human health and safety, biosecurity, and physical security, as described below.

- Health and Safety – Planning to implement composting as a carcass management option should include measures to protect workers and the public from hazards associated with loading infected materials for transport, and transporting the materials to the composting sites. Refer to the Health, Safety, & PPE Module and the Secure Transport Module.
- Biosecurity – Planning to use composting must include strict biosecurity measures to minimize disease spread when handling infected materials. Refer to the Biosecurity Module.
- Physical Security – Composting planning efforts should consider security of personnel at the infected premises, security of infected material during transport, and security at the composting sites. Below are some ideas for minimizing physical security risks:
    - Providing a single entry point to the infected premises
    - Providing badges to all authorized personnel entering the infected premises
    - Signing in and out of the premises
    - Sealing truckloads at the origin and ensuring the seals are unbroken at the destination

Waste Classification and Characterization

Classification is a determining factor in considering whether a proposed facility is permitted to accept the waste. Because regulations may vary between states, do not assume all states' waste classification regulations are similar. This is particularly relevant if waste generated during a response is transported across state lines. Consult a certified waste management professional when classifying waste.

Response personnel should perform the following:

- Identify all waste materials designated for carcass management (in accordance with the site-specific carcass management plan, if available). For more information, refer to the Emergency Management Tools Module.
- Mark waste materials and verify with the Disposal Group Supervisor that all designated materials are to be disposed of
- Sort materials by type (recyclables, putrescible waste, debris, and potentially hazardous waste)
- Prepare putrescible or other plant or animal materials for composting.
- Stage the various waste materials in suitable areas and contain putrescible or wet materials to avoid leaching to the environment until the putrescible materials can be composted. Waste materials may require tarp or shelter covering.
- Estimate the quantities of each waste type and record the information
- Characterize each waste type in accordance with all applicable local, state, and federal regulations
    - Improper waste management can result in penalties (fines or imprisonment)
    - Improperly disposed waste creates environmental contamination, and clean-up liabilities may also be incurred
    - Document the characteristics of each waste type and label all waste types in accordance with applicable regulatory requirements

Materials, Supplies, and Equipment

The Disposal Group must identify all necessary materials, supplies, and equipment to carry out the chosen site-specific carcass management method(s). The list is provided as an example of the types of materials, supplies, and equipment which are needed for composting:

- Health, safety, and PPE equipment
- Secure transport equipment (driven by trained drivers) if composting will be performed offsite
- Vehicle cleaning and disinfection equipment
- Vehicle liners, such as plastic sheeting or specialized bags
- Loading equipment (skid loaders, pay loaders, dump trucks, rakes, and scoops)
- Absorbent material to prevent leakage
- Compost thermometers (36 or 48 inch stem lengths)
- Carbon material (sawdust, litter, wood shavings, corn stover, seed and nut hulls)

Refer to the Characteristics of Raw Materials List and the Carbon Sources for Windrow Construction for additional information.

Figure 7. Example Supplies Needed for Cleaning and Disinfection

Material, Supplies, and Equipment (cont.)

- Regulatory authority approved containers, including sharps containers
- Bio hazardous waste bags and containers, if applicable Note: use biohazard bags only for identified biohazard waste. Putting non-biohazard waste into biohazard bags results in excess expenses for carcass management.

Biohazard Waste

Includes plastic ware such as pipettes or pipette tips, culture plates, specimen vials, etc. that are contaminated with biological specimens, bacterial and cell culture material, or nucleic acids. It also includes towels and bench paper that are biologically contaminated (i.e., used where samples or cultures are opened and manipulated). It may also include culture or sample containers (e.g. plastic tubes of blood) that are contaminated with biological materials. The categories are based on the UN assigned by the United Nations Committee of Experts on the Transport of Dangerous Goods (UNECE).

Secure Transportation

Transport vehicles will be needed to move carcasses and other materials to the carcass management site. If the waste must travel on public roads, it should be transported in closed, leak-resistant and/or lined trucks or dumpsters. Secondary containment may be needed, depending on the type of waste being transported. Consult a certified waste management professional when developing this section of the carcass management plan. Some transport planning considerations are listed below:

- Do carcass management facilities selected for this premises have any special requirements?
- Have the carcass management facilities agreed to accept the type and amount of waste you plan to send them and are they permitted appropriately?
- Are all permit, agreement, and/or contract conditions delineated and will the shipments meet the conditions? If not, what corrective actions would be needed?
- Are haulers to be used for the response properly equipped to haul carcasses in accordance with all applicable laws?
- Are transport vehicles designed to handle the materials to be transported?
- Are the drivers adequately trained in biosecurity ?
- Can two-way communications be maintained with the hauler during transport?
- Do shipments require law enforcement escorts?
- Will travel routes from the premises to the carcass management site avoid uninfected farms, road construction, neighborhoods, and densely populated areas?
- Has an alternate travel route been identified?
- What procedures will be followed if the vehicle is damaged during transit?
- How is the waste classified for transport? What packaging standards apply? Are all standards consistently met, including labeling, placarding, and manifesting, if required?
- How will transport vehicle traffic be minimized into the Control Area?

For more information, refer to the Secure Transport Module.

Site Suitability

Members of the carcass management team must contact or visit the premises and/or the appropriate state regulatory authorities to ensure composting is accomplished in accordance with all applicable laws and regulations.

During an animal disease outbreak, the carcass management team should consider the following:

- Selection of environmentally suitable locations for composting of infected livestock carcasses is important in the disease management process
- Because of the virulent nature of many pathogens, it is important to locate such sites within or in close proximity to the infected premises
- The site access should be able to handle heavy truck traffic and allow for biosecurity around the site's perimeter
- Due to the relative putrescibility of the carcasses and associated manure/bedding, it is critical to choose sites that will not be adversely impacted by potential releases of nutrient-laden leachate nor will result in nuisance complaints in the event that odors, flies, or scavengers begin to appear on-site

Operations Lesson Overview

This lesson contains general procedures in preparing for and managing carcasses by utilizing composting. The following topics will be addressed:

- Composting procedures
- Health and safety
- Temperature monitoring

Critical steps used during recent U.S. animal disease outbreaks are also included.

Figure 8. Carcass Management Team Wearing PPE

Operations Lesson Contents

This material in this lesson is presented in a step-wise manner that provides detailed instructions and key steps based on the criteria and measures instituted during recent U.S. animal disease outbreak responses.

- Incident Management – Discusses general guidelines to the Disposal Group personnel when dealing with an animal emergency situation
- Pre-Compost Windrows – Describes procedures for managing carcasses while awaiting resources for constructing final windrows
- Composting Poultry And Other Livestock – Details step-by-step procedures for safe and proper management of infected carcasses
- Windrow Construction Approval – Presents the checklists used by officials to verify windrow construction meets criteria and protocols
- Temperature Monitoring Procedures – Provides guidance for conducting safe and proper temperature monitoring and recording

Incident Management

All Disposal Group personnel should familiarize themselves with the approved site-specific carcass management plan. The Disposal Group Supervisor should review the plan with the Disposal Group and brief them on all relevant aspects of the carcass management effort. For further guidance, refer to the FAD PReP APHIS Foreign Animal Disease Framework: Roles and Coordination .

1. The Incident Coordination Group (ICG) / Incident Management Team (IMT) should ensure there is a system in place to identify carcass management team members with the required expertise.
2. The Disposal Group Supervisor, Disposal Coordinator, or other assigned official should verify credentials, training, and security clearances and arrange just-in-time training as needed for carcass management team members.
3. The Disposal Group Supervisor should prepare briefings and reports for the Operations Section Chief.
4. The Safety Officer should brief all responders on safety precautions and will provide a briefing on the nature of the disease and other circumstances affecting the response.
5. The Safety Officer or Biosecurity Officer should brief all responders on biosecurity protocols.
6. Plans should be developed to be sure that all onsite carcass management related personnel are briefed on safety requirements, site conditions, and tasks
7. The Public Information personnel should develop material, such as Frequently Asked Questions, to address public concerns.

Pre-Compost Windrows

Applicability: This method can be used after poultry have been euthanized to stabilize the carcasses if the resources to build the final windrows are not immediately available. This will only be used in certain circumstances, and is not a routine step.

Description: This method, which increases the amount of carbon material mixed within the windrow core, involves forming two pre-compost windrows, capping them, and then forming one final windrow at a later time. This is especially useful when dealing with large amounts of carcass material relative to litter, creating a significant carbon to nitrogen (C:N) imbalance, or when additional carbon material will increase porosity. Forming pre-compost windrows also stabilizes the tissue and begins a heating process until a single windrow can be constructed.

Figure 9. Pre-Compost Windrow

Pre-Compost Windrows (cont.)

Building Pre-Compost Windrows

- Move litter and carcasses from along sidewalls and the center of the house, forming two pre-compost windrows extending the length of the house
- Cap each windrow with 8-12 inches of suitable carbon material

Building Final Windrow from Two Pre-Compost Windrows

- In the center of the house, construct a 12-15 feet wide base that is 10-15 inches deep
- Combine both capped windrows onto the base, mixing litter, carcasses, and added carbon material
- Cap the final windrow with 8-12 inches of suitable carbon material if the carbon material is readily available on the site

Figure 10. Final Windrow

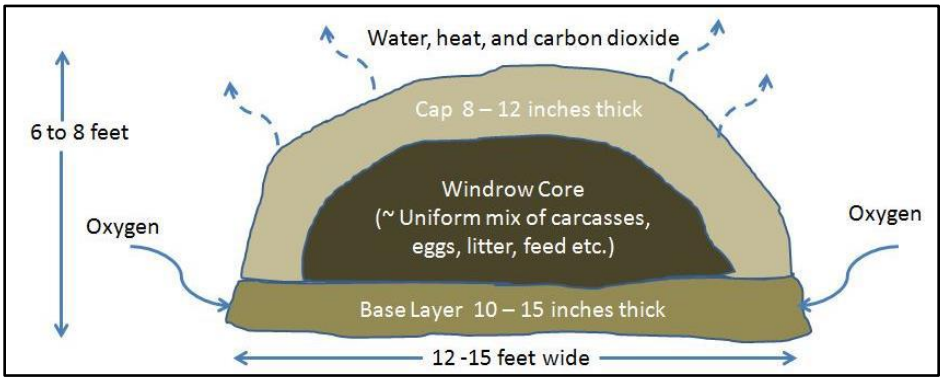
Composting Poultry

1. Identify service providers for:
    - Mortality Composting Subject Matter Expert(s) to guide equipment operators during windrow construction. Note: APHIS maintains a roster of emergency mortality composting subject matter experts who have met specific training/experience standards.
    - Heavy equipment operators who are trained on operational procedures, composting procedures and the proper handling of infected carcasses.
    - Suitable carbon material (see Carbon Sources for Windrow Construction)
2. Identify regulatory requirements and obtain pre-approval.
3. For indoor composting, ensure facility:
    - Has sufficient space to maneuver composting equipment
    - Has sufficient open space and ceiling height to construct windrows 6 feet high and 12 feet wide (double-deck houses with columns restrict such formations)
    - Is located in an area that is accessible for delivery of carbon material and compost removal
    - Has access doors that can be secured against vandals, scavengers, or disease vectors
4. Obtain all necessary equipment, supplies, materials, personnel, and services identified in the Site Specific Carcass Management Plan. Refer to the Emergency Management Tools Module.
5. Ensure all compost team members are trained on proper procedures for composting infected carcasses, biosecurity procedures, work safety issues, and the use of PPE. Refer to the Health, Safety, & PPE Module.

Composting Poultry (cont.)

6. Before outside composting, an adequate site must be identified. Site modifications and approval from State and local agencies may be required.
7. Three critical elements of windrow construction are: 1) a porous base layer, 2) a uniformly mixed windrow core, and 3) an adequate cap. These steps may be done concurrently or as separate steps.

Figure 11. Windrow Construction



8. Constructing the Windrow Base.
    - Before in-house composting, clear carcasses and litter from the windrow location(s) of the poultry house to create a 12-15 foot wide work area
    - Distribute the cleared material to both sides of the composting area
    - Using the largest skid loader possible, begin building the windrow base
    - Windrow base should be 12-15 feet wide with a depth of 10-15 inches.
    - Carbon material for the base should be porous and bulky enough to allow adequate air flow into and through the windrow. Ideal materials for the base include bark mulch or coarse wood chips. Other acceptable materials include: chopped straw, wood shavings, active yard-waste compost, small grain hulls, and corn stover. Coarse woody material in excess of 2 inches in size should be avoided to ensure that the resulting compost can be land applied as a soil amendment.
    - If these materials are not available, livestock litter/bedding may be used for the windrow base if it is sufficiently dry, porous, and bulky
    - To maintain the base's porosity and to avoid compaction, do not drive equipment on the base

Composting Poultry (cont.)

8. Constructing the Core.
    - The windrow core should consist of a uniform mix of carcasses and litter. To get a uniform mix scoop litter and birds together in each bucket load and add it to the windrow in a manner that thoroughly mixes the contents, or use a layering method (see protocol).
    - If additional carbon material is needed, it should meet the criteria in the Carbon Sources for Windrow Construction
    - Remaining feed should be blended and mixed with the carcasses and litter before windrow construction
    - Infected material should be moved as little as possible
    - The mix of carcasses and litter should be added from both sides of the windrow. This allows the operators to reach the center of the windrow and avoid tamping and compressing the base with the tires or tracks of the loader.
    - The core should have approximately 1 foot of base material exposed on both sides
    - Add water as needed
    - The core should be dome-shaped and of sufficient height (about 6 feet) to include the litter and carcass mix from the area adjacent to the windrow
    - Build the core until all the litter and carcasses have been placed on the base

Figure 12. Core Construction

Composting Poultry (cont.)

9. Capping the windrow.

    - Prior to capping the windrow, remove any carcasses that are near the edge of the windrow base and include them in the core of the windrow
    - Cap the windrow with 8-12 inches of a suitable carbon material
    - Carbon material for the cap should prevent flies from contacting carcasses, serve as an insulating blanket, and allow air to flow out of the piles. This material may be finer in texture than the base.
    - Suitable material includes small grain hulls, sawdust, new bedding, and wood chips. Avoid products such as straw or corn fodder which can blow off the windrow if the windrow is constructed outdoors.
    - Uniformly cover the entire core with cap material leaving no carcasses exposed
    - Avoid tamping and compressing the windrow. Do not operate the loader's tires or tracks onto the sides of the windrow while capping.
    - The completed windrow should be approximately 6-8 feet high

Figure 13. Capping the Windrow

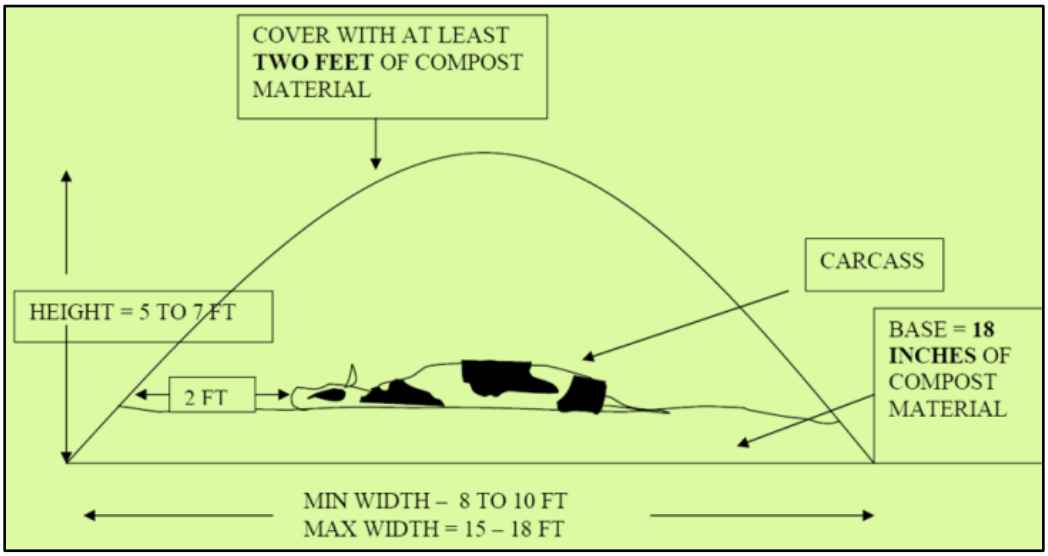
Composting Large Animals

1. Identify service providers for:
    - Mortality composting. Personnel should be trained on operational procedures, composting procedures and the proper composting of carcasses.
    - Heavy equipment operations
    - Carbon source production and delivery (2-3 pounds per pound of carcass)
2. Identify regulatory requirements and obtain pre-approval.
3. Identify a composting site that is:
    - Large enough to accommodate the windrows (24 feet wide X 6 feet high) plus staging and access areas
    - Located away from neighbors and out of sight
    - At least 200 feet from drinking water wells, surface water, and environmentally sensitive areas
    - Downwind of homes and other dwellings; accessible in all weather
    - Clear of underground and overhead utilities not interfering with traffic
    - On a crowned grade where storm water will not accumulate
    - Void of excess water
    - Capable of being dedicated to composting for several months
4. Obtain all necessary equipment, supplies, materials, personnel, and services identified in the Site Specific Carcass Management Plan. Refer to the Emergency Management Tools Module.
5. Ensure all compost team members are trained on proper procedures for composting infected carcasses, biosecurity procedures, work safety issues, and the use of PPE. Refer to the Health, Safety, & PPE Module.
6. If desired, fence the area and install measures to prevent water run-on and run-off.
7. Construct an impermeable pad if excess leachate production is a concern. The pad could consist of a low-permeability soil base, pavement, or a suitable liner material beneath the pile. The liner should not cause the compost material to slip during inclement weather.
8. Place a 24 inch bed of bulky, absorbent organic material such as 3 inch wood chips over the pad. Ensure the base is large enough to allow for 2 foot clearance around the carcass.
9. Lay animal in the center of the bed. If needed, lance the rumen to avoid bloating and possible high pressure release of gases which can result in odor problems and disturbance of cover material.

Composting Large Animals (cont.)

10. Cover carcass with 2 feet of dry, high-carbon material, old silage, sawdust or dry stall bedding (some semi-solid manure will expedite the process). Do NOT stack medium-sized, large, or very large carcasses on top of one another. For young animals, layer no more than 1 foot thick with a minimum of 2 feet of carbon material between layers.
11. Let sit for 4-6 months, then check to see if carcasses are fully degraded. Do not turn piles for at least 4 months.
12. Remove large bones before using the finished compost.
13. After building the compost piles, disinfect all tools, equipment and other items that may harbor pathogens, and maintain site cleanliness to deter scavengers, control odors, and help good neighbor relations.
14. Maintain a log of temperature, moisture, content, odor, vectors, leachate, spills and other unexpected events.
15. Monitor the internal compost pile temperatures daily with 3-4 foot long compost thermometers. The optimal temperature range for composting is between 110°F and 140°F (43°C and 60°C). During periods of extremely cold weather, piles may need to be larger than usual to minimize surface cooling. As decomposition slows, temperatures will gradually drop and remain within a few degrees of ambient air temperature.

Figure 14. Cross Section of Large Carcass Windrow



Composting Large Animals (cont.)

16. If the compost pile does not rise to expected temperature levels within the first 2 weeks of composting, evaluate the initial pile formulation for proper C:N ratio (30:1) and the mixture of co-composting materials and carcasses.
17. If the compost pile does not rise to expected temperature levels within the first 2 weeks of composting, evaluate the initial pile formulation for proper C:N ratio. (30:1) and the mixture of co-composting materials and carcasses.
18. If building an aerated static pile, the pile must be insulated (covered with a layer of bulking material or finished compost) and maintained at a temperature of not less than 131°F (55°C) for at least 3 consecutive days, monitored 6-8 inches from the top of the pile, to meet pathogen reduction standards typically used for land-applied sewage sludge.
19. Periodically test the moisture content of the compost. Use analytical equipment or the hand squeeze method. For the hand-squeeze method:
    - Squeeze a handful of compost material firmly several times to form a ball.
    - The characteristics of the ball indicate the moisture content:
        - If it falls apart, the moisture content is much less than 50 percent
        - If it remains intact after being gently bounced three or four times, it is nearly 50 percent
        - If the ball texture is slimy with a musty, soil-like odor and liquid squeezes out, the moisture content is more than 50 percent
    - If the moisture content is low and the pile temperature is very high (150°F), rake back the compost cover layer (up to 1 foot) and add enough water to bring the moisture content in the pile up to 50 percent.
    - If liquid begins to leach out of the pile, spread an absorbent organic material such as sawdust around the pile
20. Thoroughly clean and disinfect all of the disposal equipment. See the FAD PReP SOP15: Cleaning and Disinfection and FAD PReP SOPs: Biosecurity.

Windrow Construction Approval

The Composting SME will observe the windrows to ensure they have been constructed consistent with relevant criteria and protocol. If the windrows do not meet the established criteria, the SME will recommend corrective action.

Below is the questionnaire section of the Initial Compost Windrow Construction Approval Checklist, used primarily for avian influenza infected poultry flocks.

Figure 15. Initial Approval Checklist

		Yes	*No*	*N/A*	*Comments/Description*
	INITIAL WINDROW DESIGN				
1	Height between 6 and 8 feet tall.				
2	Width between 10 and 15 feet wide				
3	Base between 10 and 15 inches thick				
4	Dome shaped without significant irregularities				
5	No soft tissue visible on the surface of the windrow				
6	A minimum of 8 inches of carbon cover material				
7	Photos taken				
8	Sketch of flag locations with dimensions attached				

Windrow Construction Approval (cont.)

The Phase 1 Windrow Approval Checklist is used 14 days after construction to verify compliance with the protocol and windrows have reached prescribed temperatures. The Phase 2 Windrow Approval Checklist is used 14 days after Phase 1 is completed to verify that the compost may be moved without restriction on the premises or may leave the premises with appropriate permits. Both checklists are primarily used for avian influenza infected poultry flocks.

If the State Animal Health, APHIS or IMT Official determines the windrows have not been constructed consistent with the outlined criteria or temperatures have not reached an avg. temp. of 131°F(55°C) for a minimum of 72 consecutive hours, then the windrows should be evaluated by a Composting SME.

Below is the questionnaire section of both lists.

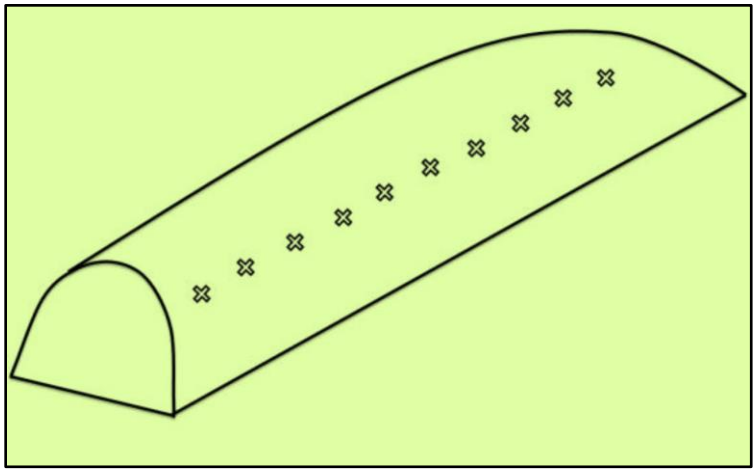
Figure 16. Phase 1 & Phase 2 HPAI Response Approval Checklist

		Yes	*No*	*N/A*	*Comments/Description*
	PHASE 1 WINDROW EVALUATION—Days 1–14 **PHASE 2 WINDROW EVALUATION—Days 14–28**				
1	Height between 6 and 8 feet tall				
2	Width between 12 and 15 feet wide				
3	Dome shaped without significant irregularities				
4	No soft tissue visible on the surface of the windrow				
5	A minimum of 8 inches of carbon cover material				
6	Moisture adequate				
7	Leachate present				
8	Excessive flies				
9	Vector activity observed				
10	Odor observed: VOA, putrid				
11	Temperature measured at 18 inches and 36 inches				
12	Temperatures reached 131 °F for 72 consecutive hours				
13	Photos taken				

Temperature Monitoring and Recording

1. Monitor temperatures of the windrow daily at 10 to 12 flagged locations. The locations should be spaced equidistantly the length of each windrow.
    - Take two temperature readings at each flagged location; one reading at a depth of 18 inches and another reading at a depth of 36 inches
    - Mark the thermometer probe at 18 inches and 36 inches. Place the temperature probe ¾ of the way up the windrow at a 45 degree angle. Ideally, temperatures should be monitored by a single individual for consistency.
    - Temperature probes should be calibrated before use

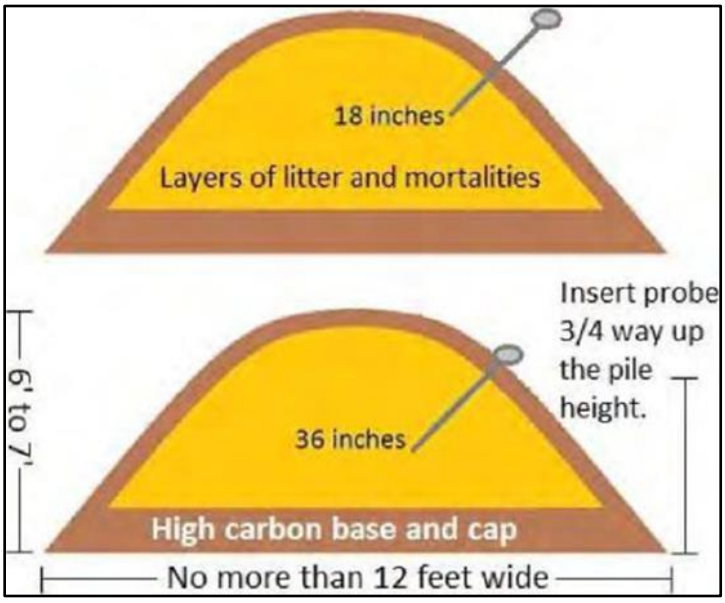
Figure 17. Temperature Monitoring Locations



Temperature Monitoring and Recording (cont.)

2. Turn on fans or open the doors and curtains to all the houses containing compost piles to allow them to air out and to maximize ventilation.
3. Use the buddy system. Entering a barn with potential inhalation hazards caused by conditions such as unmanaged carcasses, and/or high ammonia levels requires a two person team.
4. Place the stem of the thermometer approximately 18 inches and then 36 inches into the compost pile half way up the pile at a 45 degree angle.
    - Leave the thermometer at each depth and point for at least 60 seconds
    - Log the reading from the thermometer from each flag and at both depths
    - Compare readings to previous day's readings

Figure 18. Temperature Monitoring



Temperature Monitoring and Recording (cont.)

5. After completing the house readings, close the doors and curtains.
6. Calculate the average temperature for each pile and note it on the Composting Temperature Log.
7. Windrows should reach an average temperature of 131°F (55°C) for a minimum of 72 hours or be assessed by a SME for possible corrective measures.
8. Disinfect the thermometer and return it to its protective case.
9. Each thermometer will be kept at the respective premises being monitored. Do not take a thermometer from one premises to another.
10. If by the third day, after initial windrow construction, compost temperature averages remain below 100°F (38°C) or greater than 160°F (71°C), then consult a compost SME.
11. During Phase 2, a compost SME should be consulted immediately if any monitoring location is consistently (more than three consecutive days) below 100°F (38°C), or greater than 160°F (71°C).

Figure 19. Example Temperature Log

COMPOSTING TEMPERATURE LOG											
County:					Site Number:						
Street address, city, state:											
Farm Name:											
House Number:		Date Started:			Date Finished:				Date Turned:		
Use the cells below to record the temperatures each day at 18 inches and at 36 inches.											
Date Depth	1	2	3	4	5	6	7	8	9	10	Avg
18"											
36"											

Summary

Congratulations! You have completed the Composting Module. In this module, you have learned to:

- Describe composting as a method for carcass management
- Understand the advantages and disadvantages of composting
- Consider environmental risks associated with composting
- Obtain regulations governing composting by consulting with state officials
- Identify factors used to evaluate composting as a carcass management option
- Recognize key components of composting operations

Please click here to download the certificate of completion for this module. You can enter your name on the certificate and save or print it for your records.