

Composting mortalities on farms

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EPA acknowledges Aboriginal people as the first peoples and Traditional custodians of the land and water on which we live, work and depend. We pay respect to Aboriginal Elders past and present and recognise the continuing connection to, and aspirations for Country.



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1. Glossary of key terms

Term or phrase	Definition and guidance
Aerobic microorganisms	A microorganism that survives and grows in the presence of oxygen. Absence of oxygen might kill it.
Anaerobic microorganisms	Any microorganism that does not require oxygen for growth. Presence of oxygen might kill it.
Aquifers	A geological structure or formation or an artificial land fill permeated or capable of being permeated permanently or intermittently with water.
Biosecurity	Refers to the risks of infectious diseases caused by viruses, bacteria or other microorganisms entering, emerging, establishing or spreading in Australia, potentially harming the Australian population, our food security and economy and the measures taken to minimise these risks.
Bulking agent	A usually carbon-rich material that adds structure to your compost pile and aids in aeration.
Carbon to nitrogen (C:N) ratio	A ratio of the content in carbon to the content in nitrogen in a substance or material.
Composting	A biological decomposition process in the presence of oxygen of an organic substrate by aerobic microorganisms under controlled conditions.
<i>Environment Protection Act 2017</i> (the Act)	The Act includes environmental obligations and protections for all Victorians and changes Victoria's focus for environment protection and human health to a prevention-based approach.
General environmental duty (GED)	The GED is a positive duty to proactively identify and manage environmental risk and is a shared responsibility of all Victorians. The GED requires all Victorians to reduce the risk of harm from their activities to human health and the environment from pollution and waste.
In-vessel composting	A composting process that confines the composting materials within a building, container, or vessel and that generally has a high level of control of composting parameters.
Mortalities	Refers to dead animals and their carcasses
Notifiable or exotic disease	Animal diseases that must be reported to the agricultural authorities within a defined time frame.
Pasteurisation phase	Pasteurisation, also called thermophilic phase, is an important part of the active composting phase during which the number of human and animal pathogens as well as plant propagules are significantly reduced as the composting material is heat-treated.
Soil amendment	Any material added to a soil to improve its physical, chemical or biological properties, such as water retention, permeability, water infiltration, drainage, aeration and structure as well as nutrient content and beneficial soil microflora.
Windrow pile composting	A composting process whereby placing organic materials are batched and placed into windrows, and turned periodically in order to aerate and blend the material.

2. Introduction

2.1. Background

Traditional methods of managing animal mortalities are no longer always appropriate or accessible in Victoria. Knackery and rendering services are costly and less available. Burial is often not an option because of biosecurity risks and contamination of groundwater. Incineration is now reserved for mortalities posing biosecurity issues, due to concerns with air quality.

As a result, composting of dead farm animals has become more common, as it is a simple, low cost and biosecure method to convert mortalities into a soil amendment beneficial to the farm, if done correctly. However, to be done well, composting requires knowledge, appropriate infrastructure and controls. Failure to compost mortalities correctly may pose risks to human health and biosecurity, generate odours and pollute the environment.

2.2. Purpose of this guidance

As a business owner, whether a company or sole trader, it is your responsibility to understand and manage the risks of harm from pollution and waste to people and the environment from any work you do. This document provides information for farmers who manage a small number of animal mortalities on site, outlining two processes that can be used for animals weighing more than 5 kilograms, and information about how to manage risks from your activities to human health and the environment. It also provides an overview of your legal obligations under the *Environment Protection Act 2017*.

This guidance does not provide information on composting large quantities of animal carcasses. If this is required you should contact EPA, as a permission may be required, and documentation such as a health and biosecurity risk assessment and process management plan developed.

This guideline is not intended for use in the management and disposal of large numbers of animal mortalities that result from a disease outbreak. If there is suspicion that the dead stock may have been affected by a notifiable or exotic disease, the carcass should not be composted, but instead disposed of under the direction of Agriculture Victoria. In such situations advice should firstly be sought from Agriculture Victoria as the lead agency, and then from EPA and Department of Health.

2.3. Statutory framework

2.3.1. Environment Protection Act 2017

Victoria's environment protection laws (the *Environment Protection Act 2017*) include a duty focused on prevention, called the general environmental duty (GED). This duty requires you to put in place reasonably practicable measures to eliminate or reduce the risks of harm to people and the environment from pollution and waste. A breach of the GED could lead to civil or criminal penalties if you are a business or conducting an activity, even if harm has not occurred. 'Reasonably practicable' means you must put in proportionate controls to mitigate or minimise the risk of harm. See Reasonably practicable (publication 1856) for more information.

2.3.2. Other relevant legislation and codes of practice

The agriculture sector covers a diverse range of activities and practices. Information within agriculture legislation and codes of practice can also help inform you on how to manage your risks from your activities to human health and the environment.

Some relevant agricultural legislation and codes of practice that may help you understand how to reduce the risk of harm to the environment and human health include:

- Biosecurity Act 2015
- Livestock Disease Control Act 1994
- Livestock Disease Control Regulations 2017
- Livestock Management Act 2010
- Livestock Management Regulations 2011

This list is not exhaustive. You may need to seek additional advice from a suitably qualified person or other trusted source.

2.4. Acknowledgments

This guidance document was developed by Dr Muriel Lepesteur-Thompson and Penny Flukes. We thank Agriculture Victoria for its contribution to this guidance.

3. Framework for mortality composting

Composting is an aerobic process, which means that oxygen must be present. During composting, bacteria, fungi and other microorganisms transform organic waste material such as animal carcasses into a stable soil amendment. Before considering mortality composting at your farm or premises, you should understand what setup is required depending on the nature, size and number of mortalities.

Figure 1 provides a decision tree to help you identify the right composting approach. There are also additional factors to consider when deciding which technology to adopt, such as topography, soil conditions, proximity of water bodies (including aquifers), and proximity of receptors (human and animal populations) to the composting area (Table 1).

Advice from biosecurity experts from Agriculture Victoria must be sought before composting any animals that are suspected to have died from a notifiable or exotic disease. Other avenues for disposal such as landfilling or incineration with appropriate air emissions control system may be preferable to composting for these animal carcasses.

Your capacity to compost your carcasses may be rapidly exceeded if you suffer catastrophic herd/flock losses. You must contact Agriculture Victoria in the event of a large-scale loss due to disease for emergency composting and biosecurity guidance.

Composting should not be used for any animal that has died from exposure to toxic materials (for example old batteries or painted material containing lead, chemical products or contaminated soil containing chemicals) as these may remain in the material even after composting and contaminate any land it is applied to.

Figure 1. Decision framework for composting mortalities

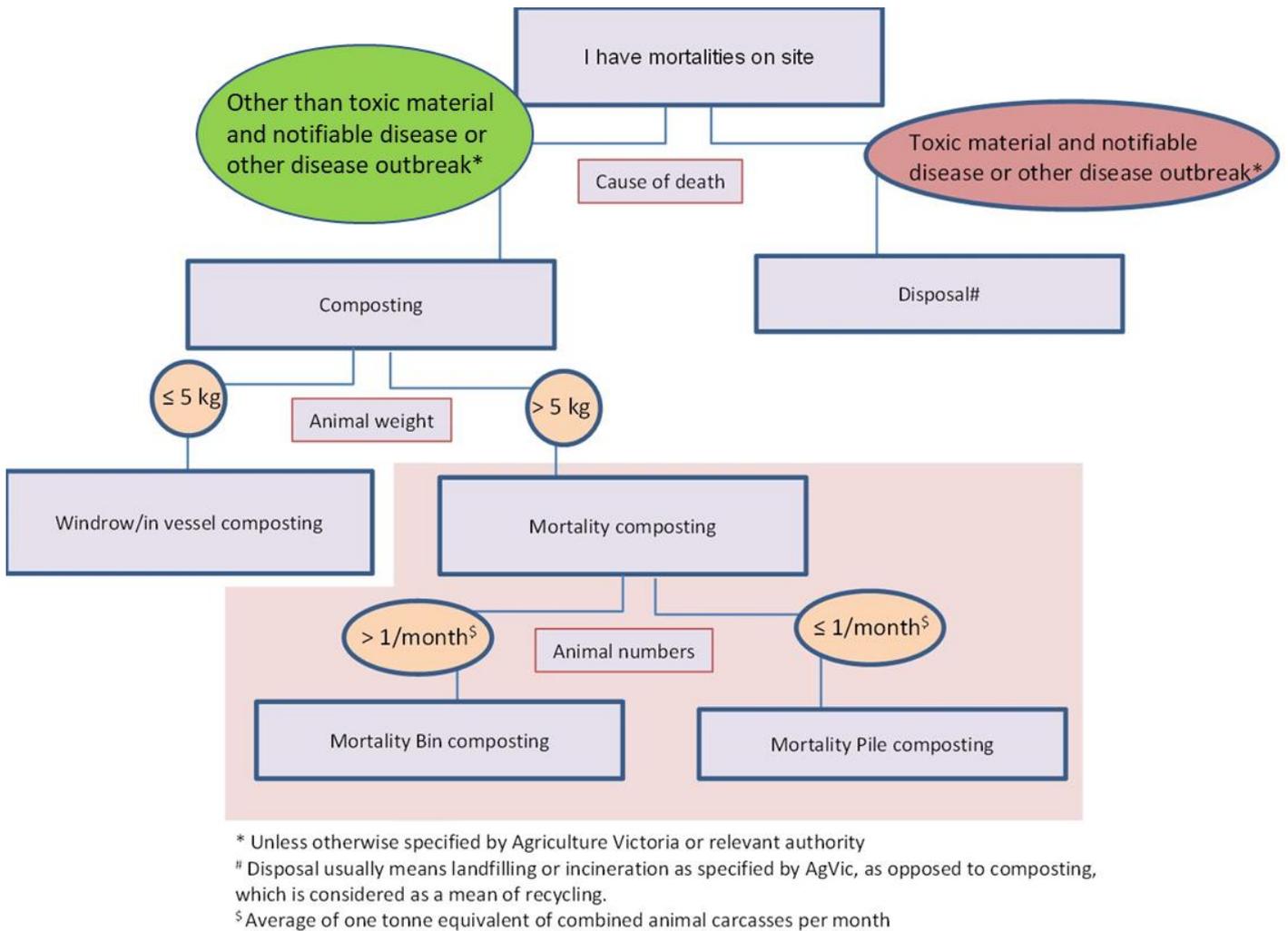


Table 1. Deciding which technology to use for composting mortalities

Composting technology	Mortality weight	Average Mortality Number	Proximity receptors	Infrastructure needs	Operational needs
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Windrow pile	≤ 5 kg	High	≥ 500 m*	low	high
In-vessel	≤ 5 kg	High	< 500 m*	high	medium
Mortality bin	> 5 kg	> 1/month@	NA#	medium	medium
Mortality pile	> 5 kg	≤ 1/month@	NA#	low	low

* Depending on the windrow size. When buffer distance is less than 500 m, further controls may be required, based on odour and risk assessment.

Nearby receptors should not be affected by odour or visual nuisance.

@ One tonne equivalent of animal carcasses per month.

It is recommended that poultry mortalities and carcasses weighing up to 5 kilograms be composted using the conventional windrow pile or in-vessel composting process described in Designing, constructing and operating composting facilities (publication 1588.1) and Australian Standard AS4454. The conventional windrow pile and in-vessel composting process is different from mortality composting because:

- the pasteurisation phase is much shorter in the conventional process, and
- it requires forced aeration or multiple turnings that could create odour issues with feedstocks such as mortalities.

Because of potential odour issues, windrow pile composting of poultry mortalities should only be used when the nearest receptors are more than 500 metres away. Further controls may be required when the nearest receptors are located less than 500m away, depending on odour levels. For more information about windrow or in-vessel composting, refer to EPA Publication 1588.1.

This document focuses on two mortality composting processes to process animal mortalities weighing more than 5 kilograms:

1. Mortality **bin** composting should principally be used in farms for small and medium carcasses (up to sheep or pig size), or when the number of large carcasses mortalities exceed one tonne equivalent of animal carcasses per month.
2. Mortality **pile** composting is usually used for large carcasses, where there is less than one tonne equivalent of animal carcasses per month.

Carcasses that have been hacked, dismembered or cut out to reduce their size can be composted using the process recommended for the size obtained. However, this practice is discouraged as it will generate additional occupational health risks for the farmer.

4. General principles of mortality composting

To compost animal carcasses, they are placed in alternating layers with a bulking agent rich in carbon, such as sawdust, straw, dry hay or corn stalks to produce a carbon to nitrogen (C:N) ratio between 15 and 35. The bulking agent captures fluids and gases produced by anaerobic microorganisms within the carcasses as aerobic microorganisms present in the bulking agent degrade them into carbon dioxide and water.

The selection of the bulking agent is important as it must allow air flow to provide oxygen, but still maintain temperature, filter odours and absorb leachates. Factors to consider include:

Bulking agents

- Bulking agents such as paper can become very compact and inhibit airflow. In contrast, branches can cool the pile as it lets too much air in.
- Manure or finished compost may be used when building the piles to replace up to 30% of the bulking agent. Make sure that any layer of manure is placed beneath a layer of bulking agent for odour control.
- The layer of bulking agent will also prevent flies, rodents and any scavengers from being attracted to the piles.

Moisture levels

- Moisture level must be adjusted and maintained, as too little moisture will reduce microbial activity while too much

moisture may create anaerobic conditions. Use the squeeze test to assess if the moisture level is appropriate.

Temperature

- The composting process requires a minimum of two heat cycles where temperatures reach 55 °C to 65°C, with a minimum of one turn in between cycles. The temperature should be monitored using a temperature probe (see Figure 2 for an example of temperature probe)
- Temperatures above 55 °C mean that fly larvae present in the carcasses should be destroyed.
- Spontaneous combustion can occur if the piles dry out, or if they are too large. Monitor temperature daily and add water as needed.
- This process should not generate any odour, provided enough bulking agent is used.

Once properly processed, the finished compost may be used on the farm, but should not be sold or distributed outside the property. Farmers wishing to sell or distribute the finished compost should contact EPA for approval.

5. Mortality bin and pile composting

Mortality composting can take place in bins or in piles according to the carcasses size and average numbers. The following sections describe these two processes.

Figure 2. Example of a temperature probe used to monitor temperature inside a pile or bin



5.1. Bin composting

5.1.1. Process

In mortality bin composting, the carcasses and bulking agent are placed into bins for a minimum of two heat cycles:

- The bin should be left undisturbed during the first heat cycle.
- When the temperature has dropped below 40 °C, the pile is turned and transferred to another bin. Only some bones, teeth and pieces of hide should remain after this first heat cycle.
- As air is introduced in the pile and the material redistributed by turning, microbial activity increases, and the second heat cycle takes place. Some water may need to be added during the turning.
- After the second heat cycle, only some large bones may remain, as bones from larger animals can take longer to decompose. Remaining bones can then be placed in an active pile (see below) for further decomposition.

The whole process takes between 7 and 24 weeks, depending on the size of the carcasses. It requires a minimum of three bins:

- The first bin is used for material being batched, once it is full, it is left for the first heat cycle

- The second bin is used for the new carcasses being batched when the first bin is full and undergoes its first heat cycle
- The third bin is used for the transfer of materials from the completed first cycle bin for the second heat cycle.

5.1.2. Size of carcasses

While animals of all sizes can be composted using mortality bin composting (including poultry, sheep, goats, pigs and cattle), this technology is primarily used for small to medium sized carcasses. However, where there are high volumes of small animal carcasses (weighing less than 5kg each), it is preferable to use windrow pile or in-vessel composting technology (refer publication 1588.1).

5.1.3. Infrastructure required

Mortality bin composting requires a concrete pad or other impermeable surface to prevent the contamination of groundwater by nutrients and pathogens, and a three-sided enclosure to prevent surface runoff:

- The pad should be able to support the weight of a tractor and the front wheels of a loader.
- The bins should be covered, ideally with an overarching roof, to prevent accumulation of rainwater.
- The bins should be built with strong materials that resist corrosion, rotting and can withstand the impacts of heavy machinery.
- A minimum of three bins is required, but large farms may need more.
- The infrastructure should be large enough to manage daily mortalities through at least two heat cycles. As a guide, 10 m³ of bin space is required for every 1000 kg of carcass.
- Access by dogs, ruminants and other animals should be prevented by the installation of a gate to the bin space or use of exclusion fencing.

Figure 3. Bin composting



Picture courtesy of the Minnesota Department of Agriculture

Table 2 provides average carcass weights and annual mortality rates that may be expected, to help plan infrastructure needs. The average annual mortality rates are based on US figures (Bonhotal et al. 2014). They are indicative only and may vary considerably.

5.1.4. Filling the bins

The sequence for filling bins is shown in Figure 4:

- First, a layer of bulking agent at least 30 cm thick should be laid.
- Carcasses should then be placed on top of that layer so that they are at least 30 cm from the bin wall and at least 15

Composting mortalities on farms

cm apart from each other.

- The carcasses should then be covered with a 30 cm thick layer of bulking agent.

Figure 4. Sequence for filling the primary composting

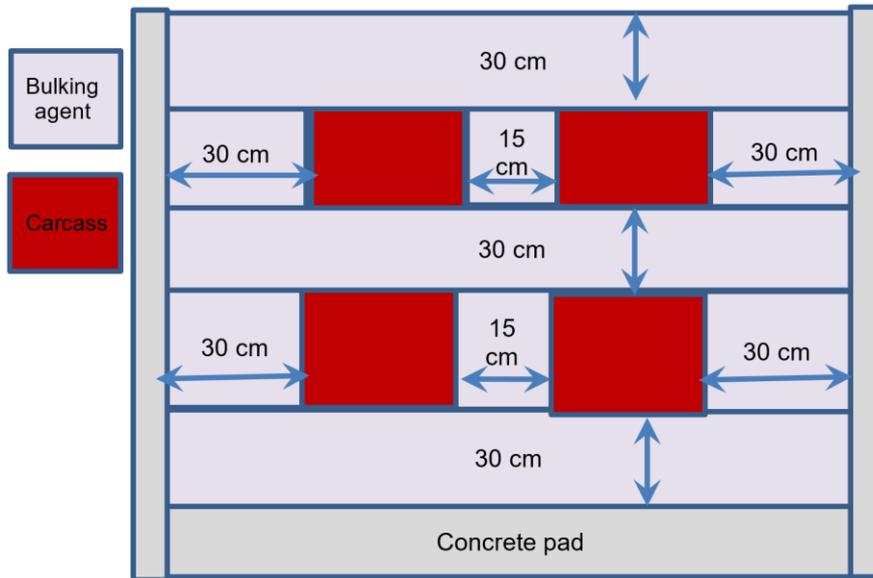


Table 2. Livestock weights and losses

Animal type	Average weight (kg)	Average loss (%)
Pig		
Small piglet	4.5	10-12
Weaned piglet	13.6	2-4
Adult pig	68	2-4
Sow	136	2-5
Poultry		
Broiler	1.4	5
Layer	1.4	10
Female turkey	4.5	7
Male turkey	7.7	13
Beef		
Calf	40.8	8-10
Weaner	272.2	2-3
Yearling	385.6	1
Cow	567	1
Dairy cattle		
Calf	40.8	8-10
Heifer	272.2	2-3

Cow	635	1
Goat and sheep		
Pre-weaned	3.6	8-10
Lambs	22.7	10-12
Adult	77.1	6-8

Source: Bonhotal et al. 2014

5.1.5. Undertaking and monitoring the bin composting process

Different animals can be composted together. The time for each heat cycle for the largest animal should be used (Table 3).

Table 3. Estimated heat cycle duration according to carcass weight

Carcass weight (kg)	Length of each heat cycle (days)
0-5	15
5-12	22
10-150	45
150-350	60
>350	120

A compost log should be maintained during the entire process, recording details of:

Species, and number of each species

- Carcass weights
- Batching dates
- Type and amount of bulking agent
- Temperature, measured in three different locations.

Bulking agent

- Monitor the bin daily to ensure that all carcasses are covered by the bulking agent. Add more bulking agent if the pile settles.

First heat cycle

- Temperatures should reach 55°C to 65°C. Monitored temperatures should be recorded in the compost log.
- Temperatures between 55 °C and 65 °C should then be maintained for at least one week after the area of the pile where you added the last carcass has reached 55 °C.
- Check the moisture content using the squeeze test and add water before or during the turn to ensure an even distribution of the moisture.

Turning the material

- The material can be turned when the temperature declines to below 55 °C after the first heat cycle.
- The turn consists of moving the material from the primary to the secondary bin. Check for the presence of flesh or small bones, as there should not be many remains if the composting process has been successful.

- Turning might generate odours, so try to turn when the prevailing wind blows away from people that may be affected by the odour. Monitor for any odours that may be generated.
- The freshly turned material should be covered with a 30 cm thick layer of bulking agent. The type and amount of bulking agent should be recorded in the compost log book.

Second heat cycle

- Temperatures should be monitored daily in three different locations within the pile during the second heat cycle and recorded in the compost log book. Temperatures between 55 °C to 65 °C should be maintained for seven days before decreasing.
- The duration of the second heat cycle should be similar than that of the first heat cycle and provided in Table 3.

The composting process is considered complete when the two heat cycles have been completed and no flesh, hide or small bones are visible. Any bone present should be brittle and easily crushed. Large bones can be placed in a new pile for further composting.

5.2. Mortality pile composting

5.2.1. Process

The mortality pile composting process involves placing carcasses above-ground in sawdust or similar bulking agent. Just like in mortality bin composting, the bulking agent provides a source of carbon, and traps fluids and odours. Several heat cycles are required to break down the carcasses.

- The pile should be left undisturbed until there is no flesh visible throughout, and only large bones remain. During this first heat cycle, the temperature reaches temperatures above 55 °C before declining.
- Then the material is turned for further breakdown. It may need to be watered to adjust the moisture content. The second heat cycle should last approximately four weeks. Large bones remaining after this second cycle should be brittle and could be crushed or placed in the next pile to be composted.
- If flesh is still visible after the second heat cycle another cycle should be initiated by turning and watering again.

5.2.2. Size of the carcasses

Mortality pile composting should be reserved for larger animals, when the average number of carcasses does not exceed 1 tonne equivalent of animal carcasses per month.

5.2.3. Infrastructure

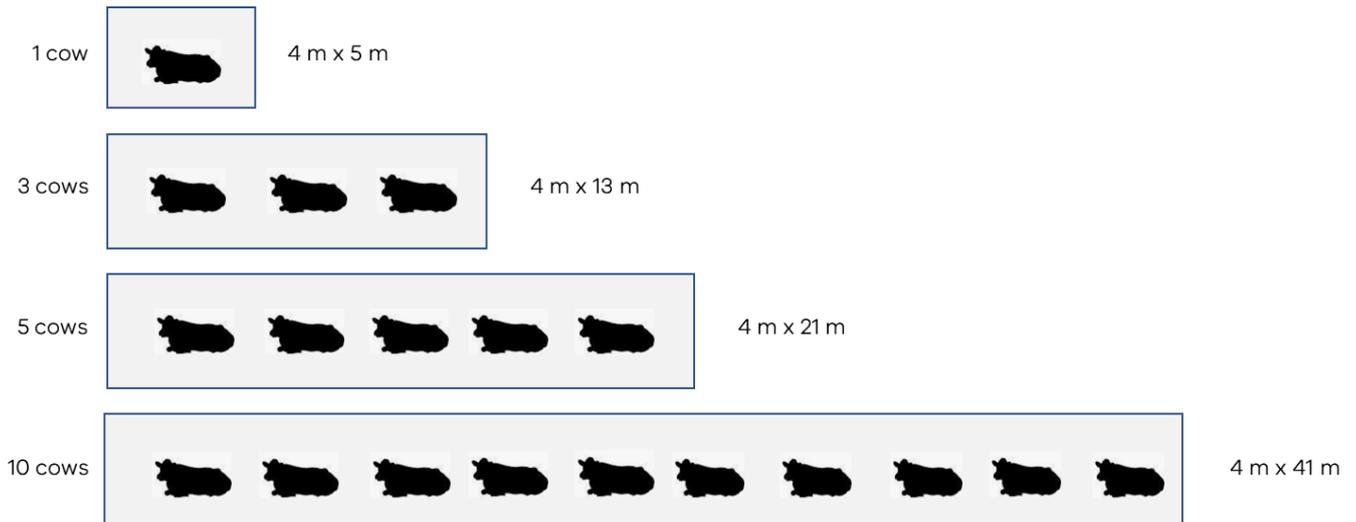
Mortality pile composting should take place on a hard stand to prevent infiltration to groundwater, preferably compacted to permeability of less than 1×10^{-9} m/s. When an existing hard stand or concrete pad is not available, a new hard stand area with all-weather access should be built. This is done by removing the top soil and creating a layer of compacted clay, crushed rock or gravel that can support tractors and front end loaders in all weather conditions.

The pad should be drained to an onsite evaporation pan for disposal. Where evaporation rates are low, material should be stored so that there is at least 12 months retention time and any reuse of this runoff water should avoid any direct contact with humans or with crops that may be consumed raw or uncooked by humans or animals. Straw bales can also be used to build a retaining wall around the mortality pile to reduce run-off.

The size of the hard stand should be at least 3 m x 4 m per cow, plus a 50 cm buffer all around the pile. It is recommended that the pile required to compost a single mature cow measures about 3 m x 4 m. Therefore, if 10 cows are to be composted per year, the hardstand should measure at a minimum 4 m wide x 41 m long (Figure 5).

The site should be fenced to prevent vermin ingress.

Figure 5. Size of the pad required according to the number of predicted cattle mortalities



5.2.4. Constructing the pile

Typically, between 10 and 12 m³ of bulking agent per cow should be used to produce the pile. Some of the bulking agent can be replaced by finished compost to a maximum of 30% of the total volume of bulking agent.

A small amount of used bedding can be mixed with the bulking agent, but a 20 cm thick outer layer of unused, clean material should cover the whole pile to prevent odour and fly attraction.

Layer the material as follows:

- Place dry bulking agent on the hardstand area (Figure 6), with a thickness of 45 to 60 cm, depending on the size of the carcasses.
- Place the carcass on top of that layer, and surround it completely by at least 60 cm of bulking agents.
- Cover the carcass with damp bulking agent. Use the “squeeze test” to check that the right moisture content has been achieved.

Figure 6. Pile construction for large carcasses

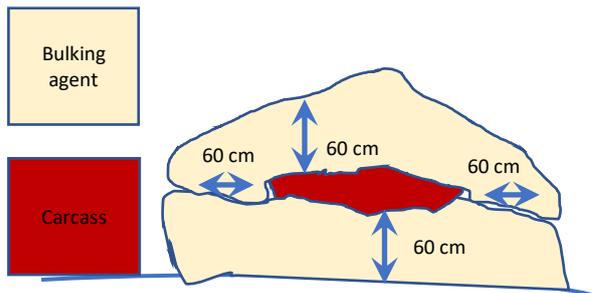


Figure 7. Example of pile composting



Picture courtesy of the Michigan State University

5.2.5. Undertaking and monitoring the pile composting process

At the start of the process, record details of the:

- date of batching,
- location of composting site,
- number and type of animal and
- approximate weight of the carcasses.

During the process, monitor and make note of the following:

- Pile temperature, recorded weekly throughout the whole composting process. Three different readings should be taken in different areas of the pile.
- Check the pile daily to ensure the carcass is still covered with the bulking agent. It may settle, or may be dug out by scavengers, which means that you may need to add more bulking agent. Bulking agent should also be added to cover any fluid that might have seeped from the pile to avoid any odour issue.
- After the approximate time indicated in Table 4 has elapsed, check regularly for any remaining flesh before turning and commencing the second heat cycle.

Table 4. Duration of the first heat cycle according to carcass weight

Carcass weight (kg)	Length of the first heat cycle (months)
5-12	2
10-150	3
150-350	4
>350	5-8

6. Selecting a site for mortality composting

The area where composting is undertaken should be carefully selected to minimise risks to human health and the environment. Aspects to consider include:

- Mortalities should be composted in an area that is not prone to flooding. Ideally, the site should be in an elevated area with a low permeability soil.
- The composting site should be located at least 1-2 m above the high water level and 100 m from water bodies.
- Mortalities should be placed and composted on a hardstand area or concrete pad.
- Any water running onto the site should be diverted.
- The site should be slightly inclined so that water is drained away and does not pool after rain.
- Any water that does run-off from the site should be collected, treated or stored until evaporated.
- A source of clean water should be available for adding moisture to the composting piles once composting is underway.
- For biosecurity reasons, mortalities cannot be composted directly next to an area where living animals are kept.
- Vehicles used for composting operations should be cleaned before entering an area where living animals are kept to avoid the introduction of pathogens.
- When selecting a composting site, wind direction and topography should be considered. It is recommended that the site is not in view of neighbours or passing traffic.
- The site should be fenced to stop other animals (including livestock) and deter people from entering.
- If transporting from another area, carcasses should only be transported on public roads if placed in leakproof and covered containers or vehicles.
- The site should have all-weather access and not be impacted by other traffic.

7. Troubleshooting for mortality composting

For composting to be effective, frequent monitoring and management is necessary. If composting is not progressing as expected, check for some of these common issues.

Problem	Probable cause	Recommendation
Temperatures between 55 °C and 65 °C are not achieved	Too dry	Add water, check with squeeze test
	Too wet	Add bulking agent and turn the pile, check with squeeze test
	Incorrect C:N ratio	Assess and add bulking agent
	Inappropriate bulking agent	Assess bulking agent and ensure appropriate cover
Fire risk due to temperatures above 70 °C	Too dry	Add water
Flesh and hide fail to decompose	Incorrect C:N ratio	Add some bulking agent while turning the pile
	Layers of carcasses are too thick	Only use single layers of carcasses
	Carcasses too close to the edge of the pile	Maintain appropriate distance from the edge (30 cm in bins and 60 cm in piles)
Odours are generated	Too wet	Add bulking agent and turn the pile, check with squeeze test
	C:N ratio is too low	Assess the bulking agent and adjust amount
	Anaerobic conditions	Maintain appropriate distance from the edge (30 cm in bins and 60 cm in piles) and turn the pile.
	Carcasses are not appropriately covered	Maintain appropriate cover thickness of the bulking agent (30 cm for bins and 60 cm for piles)
	Long periods of low temperature	See above (Temperatures between 55 °C and 65 °C are not achieved)
Presence of flies and/or scavengers	Carcasses are not appropriately covered	Maintain appropriate cover thickness of the bulking agent (30 cm for bins and 60 cm for piles). Prevent initial entry of scavengers by fencing or providing a gate or barrier
	Temperatures between 55 °C and 65 °C are not achieved	See above Temperatures between 55 °C and 65 °C are not achieved
	Too wet	Turn while adding bulking agent
	Unsanitary conditions	Maintain debris free area around the composting area. Prevent leaching and add bulking agent to trap any existing leaching

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Other stakeholders and networks

Department of Environment, Land, Water and Planning

The Department of Environment, Land, Water and Planning (DELWP) works in partnership with a range of agencies and stakeholders to protect and preserve Victoria's native landscape. DELWP directs environmental policy development for Victoria and coordinates the environment portfolio with support from EPA and Sustainability Victoria.

Agriculture Victoria

Agriculture Victoria works in partnership with farmers, industries, communities and other government agencies to grow and secure agriculture in Victoria. This department undertakes key roles across agriculture sectors in Victoria, either directly, through statutory agencies or with partner agencies across the Victorian Government. The department administers various pieces of legislation which support these activities. In addition, Agriculture Victoria also administers legislation regulating food safety, fisheries, forestry, game hunting and animal welfare.

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