Mortality Composting Design Guidance

Landowner/Operator _____ Designer _____
Location_____ Date _____
Checker_____ Date _____

The criterion below is based on:

- **Michigan Department of Agriculture, Bodies of Dead Animals Act (BODA), Public Act 239 of 1982, amended 7/7/2005.**
- **Michigan Department of Agriculture, Bodies of Dead Animal Rules, filed 9/26/2007.**
- **Michigan Animal Tissue Compost Operational Standard (MATCOS).**

ALL COMPOSTING SITES MUST MEET THE FOLLOWING CRITERIA:

Please place a check mark on the bullet for each item resolved and enter the actual distance.

Actual Distance

☐ A minimum setback of 200 feet from waters of the state. _____ ft.
- Including lakes, streams, wetlands, sinkholes, seasonal seeps, or other landscape features that indicate the area is hydrologically sensitive.

☐ A minimum of 2 feet above the seasonal high water table. _____ ft.
- As defined by the NRCS Waste Storage Facility (313) Practice Standard

☐ A minimum of 200 feet from any well. _____ ft.

☐ A minimum of 200 feet from the nearest non-farm residence. _____ ft.

☐ The composting site shall be selected and/or graded to direct surface runoff away from the site and prevent leachate from contacting surface waters.

☐ The composting site shall be located outside of floodplains. Otherwise, the site shall be protected from inundation or damage from a 25-year flood event.

Mortality Rates

For average species mortality rates and weight refer to the Michigan Animal Tissue Compost Operational Standard (MATCOS). https://www.msu.edu/~rozeboom/catrn.html

Total weight of mortality per year can be calculated using the "Long hand" method shown below or using the *Spartan Animal Tissue Composting System Planner*, an EXCEL™ spreadsheet tool (data to input shown below) which can also be obtained at https://www.msu.edu/~rozeboom/catrn.html.

Long hand method:

1. Using farm records, multiply the total number of mortalities over an average 12-month period for each species and phase of production within the species by the average weight (lb.) of that specie and phase of production. Sum all phases for the total annual mortality production.

Table 1. Example calculation of weight of annual mortality if farm-specific mortality rate is known.

Specie and production phase	Number of mortalities		Average weight, lb.		Total weight, lb.
Calves	12	x	150	=	1,800
Heifers	6	x	750	=	4,500
Milking and dry cows	15	x	1,300	=	19,500
Total weight of mortality per year					28,500*
*28,500 lbs/yr > 20,000 lbs/yr therefore mortality composting shall be done on an improved surface as defined by NRCS practice standard Waste Storage Facility (313) criteria for liners.					

2. If the farm mortality rates are unknown, refer to Table 1 in the Michigan Animal Tissue Compost Operational Standard (MATCOS) located at https://www.msu.edu/~rozeboom/catrn.html, for typical industry average annual mortality rates.

Table 2. Example calculation of weight of annual mortality if the farm specific mortality rate is unknown and industry average rates are used, citing MATCOS document.

Specie and production phase	Mortality Rate		Average Stock on Hand		Average weight (lbs)		Total
Calves	0.09	x	70	x	90	=	567
Heifers	0.02	x	120	x	600	=	1,440
Milking and dry cows	0.05	x	175	x	1,400	=	12,250
Total weight of mortality per year							14,257**
**14,257 lbs/yr < 20,000 lbs/yr therefore mortality composting may be done in piles on bare soil on land used for agricultural crop production as long as the 20,000 lbs/yr criteria is not exceeded.							

Spartan Animal Tissue Composting System Planner (https://www.msu.edu/~rozeboom/catrn.html):

1. Obtain the quantities shown in Table 3 in consultation with the farmer:

Table 3 Production information for input into *Spartan Animal Tissue Composting Planner*.

Input	Production phase			
Capacity[a]				
Days in production phase, day				
Percent mortality[b]				
Average weight, lb[c].				

[a]For estimating the weight of preweaning mortality of swine the number of farrowing stalls and the average total number of piglets born per litter are necessary inputs.
[b]Based on farm records or industry averages presented in Michigan Animal Tissue Compost Operational Standard, Table 1. https://www.msu.edu/~rozeboom/catrn.html
[c]Average animal weight during a given production phase.

Michigan Bodies of Dead Animals Composting System Requirements:

Enter the estimate of total annual mortality here: _____ lb.

• If less than 20,000 lb, see Section I below for selecting a composting system site.

• If greater than 20,000 lb. see Section II below for selecting a composting system site.

Section I:

Farms producing less than 20,000 lbs. of mortality per year may choose either of the following composting sites:

• Permanent site or sites which meet the criteria for structures (see Section II below).

• Temporary sites must meet the following criteria:

☐ A new composting site will be selected for use annually and not re-visited for 10 years.

☐ The site will be on land used in agricultural crop production.

☐ The site is not directly above any subsurface field drains.

☐ Site runoff can be managed to prevent ponding.

Section II:

- All active, finished, and cured compost shall be done on an improved surface as defined by NRCS (313) Waste Storage Facility Conservation Practice Standard, dated 11/05 (see section on Liners), and designed to withstand anticipated loads from the equipment used for placement, aeration, and movement of compost materials.

- All leachate and runoff generated at the site during active composting and curing, shall be managed with at least one of the following:

  □ Re-introduced into the compost pile.

  □ Diverted to a treatment system meeting the criteria in the NRCS Vegetated Treatment Area, (635) Practice Standard, 9/06.

  □ Collect and store leachate in a storage facility with a liner meeting the criteria defined in the NRCS (313) Waste Storage Facility Conservation Practice Standard, 11/05.

SELECT THE FOLLOWING OPTIONS THAT APPLY

(Circle one option for each bold letter below)**:**

Option	Circle one			
A. Composting System	Bins	Individual piles	Overlapping piles	Windrows
B. Wall Type	Timber	Concrete modular blocks	Reinforced Concrete	-
C. Liner type	None	Concrete pad	Synthetic with harden surface over top	-
D. Runoff Control	Roof	Wastewater treatment strip	Waste storage facility	-

Determining System Size:

Spartan Animal Tissue Composting System Planner (ATC Planner) Rozeboom and others, Michigan State University is a design tool (EXCEL™ application) which may be utilized to estimate the size of bins; the size of the pad upon which open piles or windrows are laid when composting; and the number of bins, piles, or windrows needed to deal with the amount of animal tissue generated by a farm over a given time period. It is available at: https://www.msu.edu/~rozeboom/catrn.html

In *Spartan Animal Tissue Composting System Planner* you enter dimensions of compost material in specific shapes and the months or fraction of months you plan on leaving a batch of compost in your system.

A batch is the animal tissue and amendment accumulated together in a planned period of time. Batches provide for appropriately timed temperature monitoring, aerating, and final utilization. Initial additions, or loading of new dead animals and bulking agent is limited to a planned time period which is based on animal tissue accumulations over time (determined in the first portion of this worksheet) and an appropriately sized composting system (determined in the second portion of the worksheet).

Three important inputs (text taken from Instructions page of *Spartan Animal Tissue Composting System Planner*) are:

Desired time: Enter an estimate of the number of months that will be required to start and complete the creation of a new batch. The batch may be kept in one bin or in the form of a windrow or pile. Desired time is the period over which animal tissue will be added. Most often a period of 1 month is taken to create a batch, but a range from 0.25 to 2 months may be considered depending on daily mortality rate.

Length, width, and height: Each dimension is described in a comment that will appear when the cursor is placed over the name of the measure. Enter dimensions so that batch "volume needed per desired time" is equal to or slightly greater than the "effective volume" of that batch in that selected system. Enter dimensions by "trial and error." It is recommended to compost young animals separately from adult animals as young animals will compost faster.

Duration of active composting in bin: Number of months after a batch has been created. Time required to decompose tissues is dependent on the maturity of the animals. The number of months of well-managed active composting in static batches for the decomposition of all soft tissues is shown in Table 4 below for carcasses of various sizes. Mature swine hides will persist longer than those of mature bovine or equine, and all other soft tissues.

Table 4. Months of active composting suggested for the decomposition of soft animal tissues.

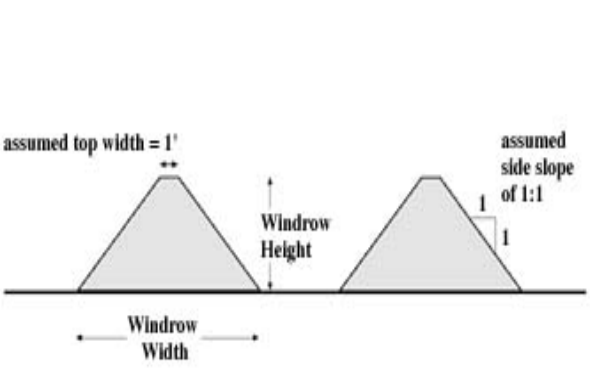
Carcass size, pounds	Suggested number of months for well-managed, active composting in static batches for the decomposition of all soft tissues
1 to 25	2
25 to 125	3
125 to 250	4
250 to 500	5
500 to 1000	6
1000 or more	8

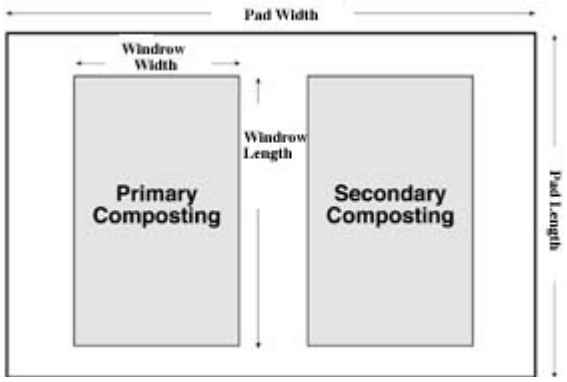
Management factors which influence system size and the duration of composting:

- Optimum biological conditions
  - Carbon-to-nitrogen ratio (C:N; on weight basis) between 15:1to 40:1.
  - Moisture content, range of 40 to 60 %.
  - Oxygen concentration of greater than 5%
    - Density (lbs./yd^3), range of 500 to 1200. In initial batch formation, this is called the target animal tissue density. It is also known as "volume factor" or "volume coefficient" or the "bulking agent to mortality ratio". This is the most important factor in determining composting volume. This density has been determined through experimentation and animal tissue composting has been successfully accomplished using densities varying from 0.05 to 15 lb./ft^3. However, when animal tissue density is greater than 10 lb./ft^3, intensive management of aeration and moisture is necessary. The *Spartan Animal Tissue Composting System Planner* default is 10 lb./ft^3. In some publications, authors devise "long hand" equations for predicting bin, pile or windrow size. A different target animal tissue density may be suggested.
    - Do not stack higher than 6 feet as the weight of the material will force air out.
- Initial carcass temperature – do not freeze.
- Initial bulking agent temperature – in cold months use warm material as 50% of compost amendment. Compost from a finished or curing batch may be used as bulking agent in a 1 to 1 mix with fresh bulking agent material to begin a new, active compost pile or batch.
- Animal tissue surface area - increase in the amount of animal tissue surface area exposed by cutting of carcass flanks, abdomen, muscles or grinding.
- Actively or forced aeration – mechanical aeration (fan and duct system within or under compost material) or temperature-based mechanical turning or mixing reduces active composting time up to 50% or more. A minimum of 3 bins is needed to effectively aerate and flow batches of mortality compost.
- Curing increases space required by about 2 to 3-fold depending again on the extent of previous composting activity and the management of the curing batch. Curing of animal tissue compost, in part or whole, is not required by Michigan law.

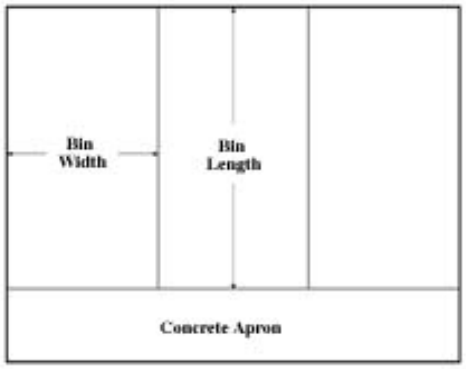
- Size of equipment - the compost bins, pad, and windrows will also depend on the size of equipment. Bin width should be at least 1 foot wider than the loader bucket used to move the compost materials and carcasses. Aprons around piles and windrows will need to accommodate loader and self-and tractor-propelled turning equipment.
- Size of carcasses - For large animal carcasses consider using a minimum bin width of 8ft.

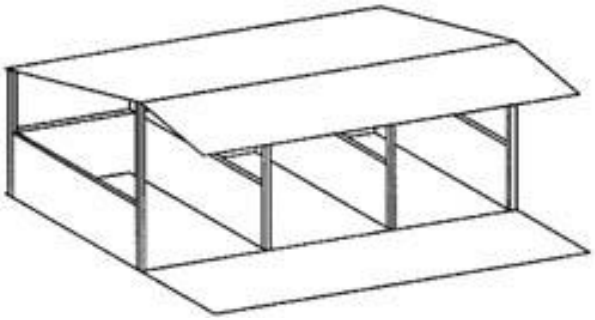
Typical Windrow System:





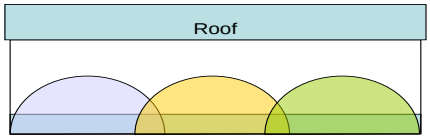
Typical Bin System:





2 ft reinforced curb down center of pad

Typical Overlapping piles:



Example:

Swine Grow-Finish operation
Capacity = 4800 (total number of animals in the phase of production during one turn)
Days per turn = 130
Percent mortality = 2%
Average Weight during phase = 155 lbs

Summary of report from *Spartan Animal Tissue Composting System Planner* (Report is shown on following page):

Bin System	Overlapping Pile System
1 month fill time	1 month fill time
5 months active compost time	5 months active compost time
6 bins needed	Pile size 11 x 15 x 4 ft.
Need 6 bins for active composting. The 7th bin is suggested for fresh bulking agent storage.	Need 6 piles; 3 pile on each side of 2 ft reinforced curb.
840 sq. ft. facility is suggested, is 27% larger than needed, but a minimum bin width of 8 ft. allows use of owned loader.	Building 30 ft wide and 33 ft long, 1390 sq. ft. which includes a 10 ft apron on each side. Keep cost down with a 30 ft. roof span

System Planner Worksheet

Name: Example Farmer
Phone: 123-456-7890
Fax: 123-456-0987

Address: Somewhere
Michigan
Some Zip

Select first type of producer: Swine
Select second type of producer: None
Select third type of producer: None

Select type of composting system: Overlapping piles

Target animal tissue density: 10 lb/ft³

Swine Animal Production Information

Item	Piglets Preweaning	Breeding Herd	Nursery	Wean-Finish	Grow-Finish
Crates:	0				
Total piglets farrowed per litter:	11.5				
Capacity:		0	0	0	4800
Days per complete turn:	21	365	70	168	130
Percent mortality:	12%	7%	5%	2%	2%
Average weight of animals during phase (lb):	4.5	450	40	125	155
Number of pigs per year:	0	0	0	0	13,477
Calculated daily mortality (lb/day):	0	0	0	0	114
Total farm mortality:	114	lb/day			

Composting System Plan Using Overlapping Piles

Design Parameters

Desired time to form pile and batch:	1	months
Length of pile:	11	ft
Width at base of pile:	15	ft
Height of compost material:	4	ft
Duration of active composting for pile or batch:	5	months
Equipment working space or apron width:	10	ft

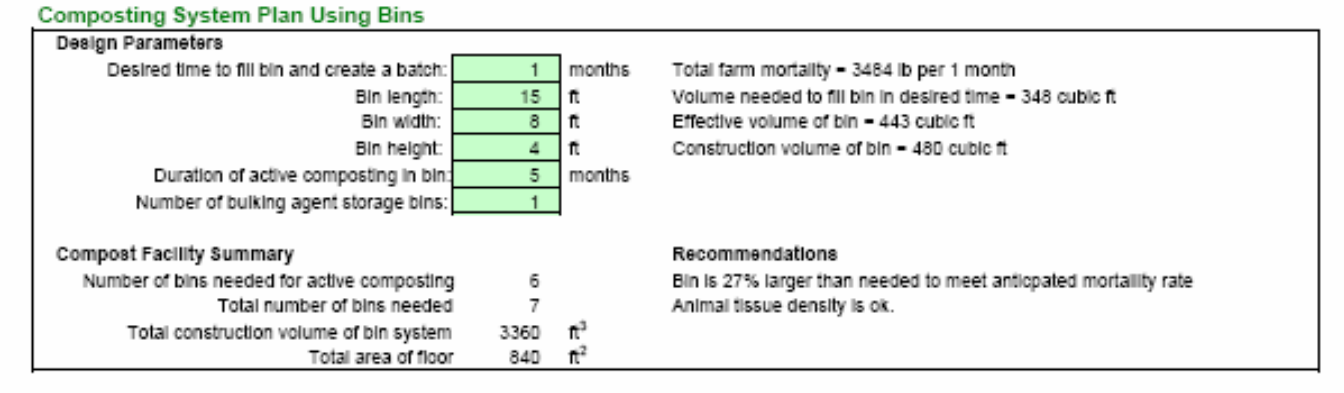
Total farm mortality = 3484 lb per 1 month
Volume needed to construct pile in desired time = 348 cubic ft
Effective volume of pile = 373 cubic ft

Compost Facility Summary

Total number of piles needed	6	
Apron area needed to form and turn piles	400	ft²
Total effective volume of piles	2238	ft³
Area of pad or floor, including working space	1390	ft²

Recommendations

System is appropriately sized for anticipated mortality rate
Animal tissue density is ok.



Composting System Plan Using Bins

Design Parameters

Desired time to fill bin and create a batch:	1	months	Total farm mortality = 3484 lb per 1 month
Bin length:	15	ft	Volume needed to fill bin in desired time = 348 cubic ft
Bin width:	8	ft	Effective volume of bin = 443 cubic ft
Bin height:	4	ft	Construction volume of bin = 480 cubic ft
Duration of active composting in bin:	5	months	
Number of bulking agent storage bins:	1		

Compost Facility Summary			Recommendations
Number of bins needed for active composting	6		Bin is 27% larger than needed to meet anticipated mortality rate
Total number of bins needed	7		Animal tissue density is ok.
Total construction volume of bin system	3360	ft^3	
Total area of floor	840	ft^2	

In addition to the *Spartan animal Tissue composting system Planner*, EXCEL™ spreadsheet, the *Spartan Compost Optimizer* EXCEL™ spreadsheet was also developed in order to simplify planning a compost recipe or mix. Located at https://www.msu.edu/~rozeboom/catrn.html

Instructions for data input are provided in the first tab of the spreadsheet.

Basic input information needed include:

- Type of materials to be used in the compost mix in either pounds or cubic yards

- Cost of the materials. Cost can be set on either pounds or cubic yards

- Identify the minimum and maximum amount of each material to be included in the compost mix

- Identify the size of the bucket loader to be used in cubic yards. This input allows the program to calculate the number of buckets of each material will be needed to prepare the compost mix.

Additional Notes: